Australian meteor crater?

Ursae Majoris

Miscellanea

for May

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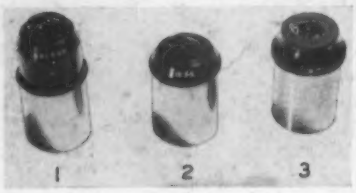

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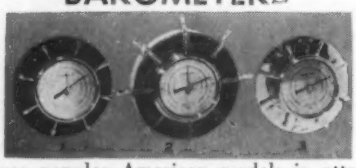

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The Editors Note . . .

BOSTON COMMON was the scene of a large public eclipse party on the evening of April 12th. Good weather prevailed in New England all day and evening, and several thousand persons at the party were afforded a perfect view of the entire celestial spectacle. Half a dozen reflecting telescopes were set up by members of the Amateur Telescope Makers of Boston, and a 5-inch Zeiss refractor and a 40-power theodolite were provided by the Boston Museum of Science. These two organizations sponsored the party with the co-operation of the Boston park department and other city agencies.

At an early phase of the partial eclipse, radio station WCOP staged an on-the-spot broadcast, during which Professor Royal M. Frye and Dr. Duncan Macdonald, both of Boston University, were interviewed on such topics of general interest as the craters on the moon and the possibility of rocket flight to our satellite.

The editor, acting as master of ceremonies, realized first-hand the tremendous appeal and significance of such affairs, long sponsored by amateur societies and other public-minded groups in such communities as Cleveland and Washington. It was to such experienced "star-party operators" that we had turned for advice in planning the party on Boston Common.

As people waited in line for their turns at the telescopes (and most took many turns), they were in a very receptive mood for astronomical information. Half a dozen speakers described nearly every phase of amateur activity and discussed subjects of general astronomical interest. Surely, if amateur groups are looking for a means to talk astronomy to a large number of people, to combat astrology, and to win new members in their local societies, a star party is an effective and highly satisfying event.

The ingredients are some substantial telescopes, each manned by two amateurs who know their instruments; ropes placed to control the queues at the telescopes; a portable outdoor loudspeaker unit; and considerable advance publicity by newspaper and radio. Complete co-operation is needed from all agencies concerned, including the local police.

Perfect weather and an eclipse of the moon help too. Why not plan an eclipse party in your community for October 6th?

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May, 1949

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COVER: The Wolf Creek crater in Australia is an arresting feature, and it was an airplane view of it that first aroused the attention of scientists. Photograph by the Vacuum Oil Company, Australia. (See page 163.)

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BACK COVER: A portion of the Coma-Virgo cluster of galaxies, photographed by Harvard's Jewett Schmidt telescope, with a 74-minute exposure, March 19-20, 1947. Zwicky has speculated that our own local group (the Milky Way, Magellanic Clouds, M31, M33, and others) may be part of the same huge cloud of galaxies in which the Coma-Virgo group may be a striking condensation. (See In Focus.)

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The newly discovered Wolf Creek crater stretches about half a mile from rim to rim. The floor is about 100 feet deeper than the plain surrounding the crater. Illustrations with this article are reproduced through the courtesy of the Australian Geographical Society, Melbourne C. 1, Australia.

The Hidden Crater of Wolf Creek*

By Charles H. Holmes, *Managing Editor, "Walkabout"*

HOLES in the earth's crust are of only passing interest to the layman, but to the scientist they are at once a challenge; they must be studied and their origins determined. Craters when seen from ground level are generally not very impressive, their contours being largely effaced by eroded edges, basins filling up with soil, and trees and scrub growing over the entire formation.

But from the air these indefinite shapes frequently become sharply etched. A crater may emerge as a striking symmetrical figure which excites the interest of all who view it. What caused it—a visitor from another world? Or is it just an old volcano? Or a sinkhole draining down, perhaps, to an artesian basin? How long ago was it formed?

This is the story of a hole on the northeastern fringe of the Desert Basin, an artesian region larger than the state of Victoria, which extends southward from the foothills of the ranges that pattern the Kimberleys division of Western Australia until it merges with the Great Sandy Desert several hundred miles to the south. The precise location is 64 miles south of Hall's Creek and 400 miles inland almost due east of Broome (longitude 127° 46′ east, latitude 19° 18′ south).

It is a hole of rather tremendous proportions, estimated to be over half a mile wide, 100 feet deep below plain level, with a rocky rim which in places rises to 100 feet above the level of the surrounding desert.

Passing nearby over the spinifex-spattered wastes, you would never know the crater existed. From plain level there is just a low ridge. Perhaps the desert nomads in their wanderings in earlier years knew of it as they chased their quarry over its rim. Maybe too they found water in the bottom of the crater, as, although it is now bone dry, there is evidence that water has accumulated there on occasion.

There was no urge for any cattlemen from distant leases to climb what was seemingly a sterile stony ridge. No cattle would be there. And so the crater existed rather secretly, its facade a stony outcrop. If cattlemen from leases on better country as close as Sturt Creek (25 miles) and Billiluna (30 miles) knew of its existence, they apparently attached little importance to it, and there is no record available to indicate that anyone ever reported its existence in earlier years.

On June 21, 1947, when flying over the Desert Basin south of Hall's Creek, where they had been making a reconnaissance in a Zinc Corporation plane in the search for oil on behalf of the Bonaparte Gulf Company Pty. Ltd., Dr. Frank Reeves, geologist, and N. B. Sauve, geophysicist, both of the Vacuum Oil Company, were intrigued to see below them a perfectly shaped crater of huge dimensions. With its basin half shadowed, it was an arresting blob on a featureless landscape [front cover].

The crater was not marked on the map as such, but there is a mark for a hill more or less in the exact location of the crater. South of the crater, some 12 miles distant, is the little-used Canning stock route. Over this stock route that stretches down the map to the Wiluna railhead, some 700 miles distant, only a few hundred head of cattle now travel each year.

The geologists wondered whether the crater was of volcanic origin or whether it had been caused by a meteorite. As a fact, it resembled in contour the great meteorite crater near Canyon Diablo in the Arizona desert, which measures four fifths of a mile across and 570 feet deep from the top of the rim. It is estimated that the meteorite that caused this Arizona crater displaced 200 million tons of rock.

There was much discussion when the geologists returned to their base at Wyndham. This was natural, as large craters of meteoric origin are rare. For instance, when those at Henbury in the Northern Territory were found (the largest is 600 feet wide), they were said to be among the largest and most interesting yet discovered.

On August 24th, subsequent to their locating the crater several months earlier, Dr. Reeves decided to visit it by traveling overland with assistant geologist H. J. Evans and Dudley Hart, who piloted the Zinc Corporation plane from which the crater had been first sighted. The trip was made by jeep from Billiluna Station, astride the Canning stock route to the south. It is also possible to reach the crater from Hall's Creek or by landing a small plane at Sturt Creek Station, 25 miles east, and going by truck or on horseback across the desert.

First impressions favored the volcanic theory, as it was hard to believe that a meteorite blast could tilt the strata so regularly. On the other hand, it is situated on a flat plain, and there is no evidence of a cone, which is usually formed by a volcano; also there was

*Condensed by permission from the Australian Geographical Magazine *Walkabout*, Vol. 14, No. 13, November 1, 1948.

Here the crater rim is viewed from the crater floor, which is 200 feet below the rim in some places. Note the figures on the skyline.

the absence of volcanic or igneous rocks.

Following a discussion with Dr. H. G. Raggatt, director of the Commonwealth Bureau of Mineral Resources, Dr. Reeves is now convinced that it is an immense meteorite crater. Dr. Raggatt and his associates were impressed with the crater's resemblance to the Arizona crater.

Dr. Reeves estimates the crater to be 2,800 feet in diameter at its bottom. He writes: "The rimrock is sixty to one hundred feet above the adjacent desert, which rises gently towards the crater and shows occasional exposures of sandstone bed rock. The walls of the crater are steep and composed of hard micaceous sandstone, probably pre-Cambrian. The sandstone is shattered and tilted at various angles outward from the crater. The rimrock of the crater consists of sandstone talus partly drifted over by wind-blown sand. Trees of considerable size grow in the bottom of the crater around a claypan in which there are sink-holes exposing calcareous tufa. No meteorite fragments were found in the vicinity, but only about two hours were spent in the locality. The fact that the crater lies in a region not crossed by scheduled plane flights and not visited by prospectors and station riders is responsible for its not being earlier discovered. Old-timers in the region had no knowledge of it."

It is believed by the geologists who have visited the crater that it antedates the coming of the white man to Australia — perhaps it was formed 300 years ago. The estimate of age is based on various factors such as the extent to which the lip of the crater was worn down in places and the soil that was filling up the crater, which had undoubtedly been much deeper when first formed. Another factor is the size of the dead trees in the crater, some of which were two feet thick. It is understood their theory is that the meteorite may have penetrated the earth some 600 feet and then exploded.

Following a release of information that the geologists had discovered the crater, former constable A. J. Jones advised that, while on patrol in 1935 to Billiluna Station some 90 miles south of Hall's Creek in a direct line, one of his blacktrackers showed him the crater. He thought the crater very old and remarked that the trees in it looked about the age of the trees on the plain outside. At any rate, in that year the crater had apparently come under the notice of the police.

The finding of the crater by the Vacuum Oil Company's geologists inspired a visit to Wolf Creek by members of a party sent out by the Australian Geographical Society, which happened to be in the Kimberleys area in August of this year [1948]. No meteoric iron could be found by this party, either, which is not surprising, as the fine texture of the desert surface moved by the winds would not take long to blanket any metal. The party was not there any length of time to make a worthwhile search. It is of interest to mention that about 1,400 pieces of meteorite iron were found in the vicinity of the Henbury craters, ranging in weight from a fraction of an ounce to about 170 pounds. An interrogation of natives in the Hall's Creek area did not indicate any aboriginal legends associated with the crater.

It is understood that during their explorations this year of the Desert Basin, the geologists of the Vacuum Oil Company plan to visit the Wolf Creek crater again, when they will endeavor to obtain further evidence of its origin.

As indicated earlier in this article, the Commonwealth Bureau of Mineral Resources recognizes the resemblance of the Wolf Creek crater to the Arizona crater and considers that it was probably caused by a meteor. The bureau states, on the other hand, that it does not necessarily follow that there is a large meteorite buried in the crater. However, any meteorite or fragments of meteorites would be readily detected by magnetic and electrical methods of investigation, and the bureau is equipped with the necessary instruments (mine detectors, magnetic balances, and so forth) to make such study. This will be arranged by the bureau the first time one of its geophysical parties is operating in the area. Work of this type was carried on at Henbury, and as a result it was concluded that no large meteorite lay beneath any of the larger craters.

And so Australia may hear something further and more definite on this, the largest crater yet found in the fifth continent, which is attributed tentatively at any rate to meteoric origin.

Indexes and Bound Volumes

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SKY PUBLISHING CORPORATION

From a distance of six miles, the crater appears as a low but conspicuous ridge. The trees line Wolf Creek.

NEWS NOTES

By Dorrit Hoffleit

HIGH-ALTITUDE FLIGHT

The scientific world may well be pleased with Army Ordnance for recently sending a missile over 240 miles up into the earth's atmosphere, where it could obtain data of great value. The highest altitude previously reached by a V-2 launched from White Sands was 114 miles. The new record was made by a two-stage rocket. In place of the usual warhead of the V-2 was installed the American-developed rocket, the WAC Corporal. After the V-2 had acquired a high velocity, the WAC was fired. The velocity of the V-2 boosted the speed the WAC could achieve independently to a maximum of nearly a mile and a half a second.

This is still far from "space travel" in the sense of escaping from the gravitational hold of the earth, which would require velocities in excess of seven miles per second. However, had this missile been launched from the moon it might have gotten away, for the moon's velocity of escape is only about 1½ miles a second.

OPERATION ECLIPSE: 1948

Everyone must enjoy the account in the March *National Geographic Magazine,* by William A. Kenney, which is replete with the drama and suspense of a whole series of eclipse expeditions. The path of the annular eclipse of May 8-9, 1948, ran from the Indian Ocean through Burma, Siam, China, Korea, Japan, and the Aleutians, a distance of over 5,000 miles. Precise observations of the four contacts at various places along this path were expected to improve our knowledge of the distances between these various countries, and nine observing parties were organized.

As reported in *Sky and Telescope* for July, 1948, page 225, bad weather at most of the eclipse stations made possible procurement of observations for only one geodetic tie-in: Siam-Japan, and storms killed all possible observations from the two ground stations in the Aleutians. Air Force B-29 Superforts achieved remarkable success over Alaska, however, although radio blackouts cancelled the story of their success, leaving the experts at home in Washington frustrated for days until the flyers themselves arrived there, unaware that their story had not preceded them.

Instructed to fly between 8,000 and 10,000 feet (above the expected weather ceiling), they had to climb as high as 29,000 feet, where one of the planes experienced engine trouble forcing it down to 27,000 feet. Despite these and other difficulties, the pilots persevered and accomplished their observing missions. Shoran stations tracked the planes so their positions at all times were determined relative to the ground stations. Future eclipses should never again prove total failures if radar tracking devices are available to follow planes flying above bad weather.

Some 100,000 separate pictures must be measured and correlated with various other data before final results of the annular eclipse will be available, a matter of many months work.

MORE WHITE DWARFS

Faint stars of large proper motion provide Dr. W. J. Luyten, of the University of Minnesota, a happy hunting territory for the discovery of white dwarf stars. Last summer he brought the total number of known white dwarfs up to 100. This was made possible through the participation of the Steward and Cordoba observatories, which provided the necessary color data on the stars for which Dr. Luyten's proper motion data based on Harvard plates indicated high velocity. On Harvard Announcement Card 984 Dr. Luyten and David McLeish, of the Cordoba Observatory, announce seven more such stars, all with photographic magnitudes between 14.4 and 17.3, and far in the southern hemisphere of the sky.

JOSEPH HAINES MOORE

Joseph Haines Moore, beloved director of Lick Observatory from 1942 to 1946, died March 15th at the age of 70. He had been associated with Lick for more than 45 years. From 1909 to 1913 he was in charge of the Mills expedition to Chile, where the Lick astronomers obtained still unexcelled spectra of the bright southern stars. Dr. Moore took part in five solar expeditions. His published papers contain contributions on stellar and solar spectra, radial velocities, motions in the solar corona, and the rotation periods of Uranus and Neptune.

"STERNENWELT"

Amateurs and others interested in astronomy who prefer the German language will enjoy the new popular magazine, *Sternenwelt,* edited by Professor Erich Schoenberg of Munich. The first issue, January, 1949, is an auspicious beginning, giving lucidly written articles on a wide variety of topics, for example, interesting minor planets, new methods in astronomical photometry, solar prominences, and sources in the history of astronomy. There is also handbook information for those who would do some observing.

The periodical is sponsored by the University of Munich Observatory and is the official organ of the German amateur telescope makers and amateur astronomers, now organized as the "Volkssternwarte, e. V., Munich, Germany."

A POSSIBLE METEORITE CRATER

In the Contributions of the Meteoritical Society (*Popular Astronomy,* March, 1949), Dr. Lincoln LaPaz, of the University of New Mexico, reports on the discovery by Major Charles L. Phillips, USAF, of a possible meteorite crater in northeastern New Mexico. It is on a mesa 7,000 feet high, in an uninhabited area difficult of access. Nevertheless, Major Phillips later hazarded a landing with an L-4 plane in order to examine his find. The crater is nearly circular, about 30 feet in diameter and three feet deep. From its incomplete coverage by vegetation it is estimated to be less than 20 years old.

The article suggests that the crater may be associated with the meteorite fall of March 24, 1933, although it is much farther south and west than might be expected on the basis of authentic recoveries from that fall. The crater was discovered during a search by members of the Civil Air Patrol for possible meteorites associated with a spectacular meteoric display on December 5, 1948.

BILLIONS AND TRILLIONS

In October, the ninth general conference on weights and measures was held in France. Established by treaty in 1875, this international organization has held regular meetings since 1889, except for the interruptions due to two world wars. This was the first meeting since 1933.

One topic of discussion was the naming of large numbers, particularly those whose designations commonly end in *-illion.* In some countries, including the United States, we call 1,000 million a billion and 1,000 billion a trillion. In Great Britain and elsewhere, on the other hand, a billion is a million million and a trillion is a million billion (10^{18}). The conference hoped to reach some agreement, preferring the six-digit groups to our three-digit groups. The United States delegates could not agree to the recommendation, and the resolution adopted proposed the uniform use of the six-digit terminology throughout Europe.

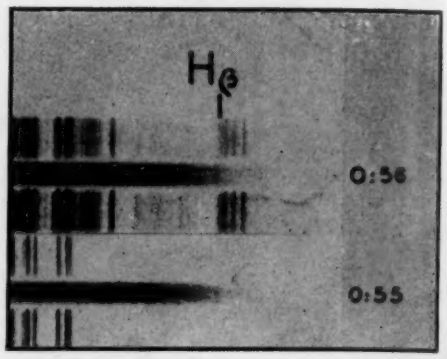
AN EMULSION FOR THE EXTREME ULTRAVIOLET

Photography of the solar spectrum from high-altitude rockets has stimulated further research into suitable photographic emulsions. Eastman Kodak Research Laboratories have developed a "vacuum ultraviolet emulsion" which, according to Science Service, has extremely close-packed silver grains with very little gelatin. At high altitudes the atmosphere no longer filters out the ultraviolet solar radiations. Hence the new emulsion was tested in a vacuum spectrometer where it was exposed to a high-intensity spark rich in ultraviolet.

UX URSAE MAJORIS

BY ALBERT P. LINNELL*
Harvard College Observatory

(Left) Fig. 1. The photoelectric photometer is mounted on the top rim of the tube of Harvard's 61-inch Wyeth reflector. The box next to the photometer is part of the telescope's spectrographic equipment. Photo by Robert E. Cox.



(Right) Fig. 2. A portion of spectra of UX Ursae Majoris taken after primary minimum, showing the hydrogen-beta line in emission (dark). Photograph, courtesy Yerkes Observatory.

IN 1933, S. Beliavsky published a list of 10 new variable stars.[1] Among these was an eclipsing binary which has become famous for the shortest known period — four hours and 43 minutes. Its name is UX Ursae Majoris; its location is R.A. $13^h\ 32^m\ 42^s$, Dec. $+52°\ 25'.4$ (1900). The star is faint, almost 13th magnitude at maximum brightness.

Zverev and Kukarkin[2] were the first to make an extended study of this system. They observed the star visually in 1933, 1935, and 1936. Perhaps their most surprising result was the relative constancy of light between eclipses. Normally, one would expect such a short-period system to be of the W Ursae Majoris type, in which the close proximity of the component stars causes tidal and reflection effects that make brightness changes practically continuous between eclipses as well as during them.

The fact of constant light between eclipses (giving a light curve somewhat similar to that of Algol) indicates stars smaller and denser than the sun, their characteristics placing them on the Russell-Hertzsprung diagram somewhere in the region between the main sequence and the white dwarfs. One component is of early spectral class ($B3$) and the other one late. Visually, the primary minimum is one magnitude deep — thus, the star changes in apparent brightness by about 2½ times from maximum to minimum. Zverev and Kukarkin claimed to have found a shallow secondary minimum (bright star in front of fainter) only 0.08 magnitude deep, at phase $0.^P50$, halfway between the primary minima. Whether the secondary minimum they observed is real or not, there must be a secondary minimum at some time, for the great depth of the primary minimum excludes the possibility that the period of revolution of the stars about each other is double the time between the observed deep minima. Unfortunately, the eclipses of the system are only partial, so the elements of the binary cannot be determined by observations during primary minimum alone.

In 1939, Krat[3] observed the star photographically at Poulkovo Observatory. The faintness of the star required exposures of two to 2½ minutes — a disadvantage during minimum when the brightness changes very rapidly. Krat also thought he detected a secondary minimum, somewhat deeper than that found by the original observers, and at phase $0^P.55$. He states in his article that the secondary minimum is ill-defined. Actually, since the star of later spectral class (redder) undergoes eclipse at secondary minimum, we would expect the photographic minimum to be shallower than the visual one, rather than deeper.

G. Kuiper[4] classified the spectrum as that of a $B3$ subdwarf, from spectrographic studies at McDonald Observatory. In 1948, O. Struve[5] found the hydrogen and helium lines to behave in an unexpected manner with respect to the times of eclipse.

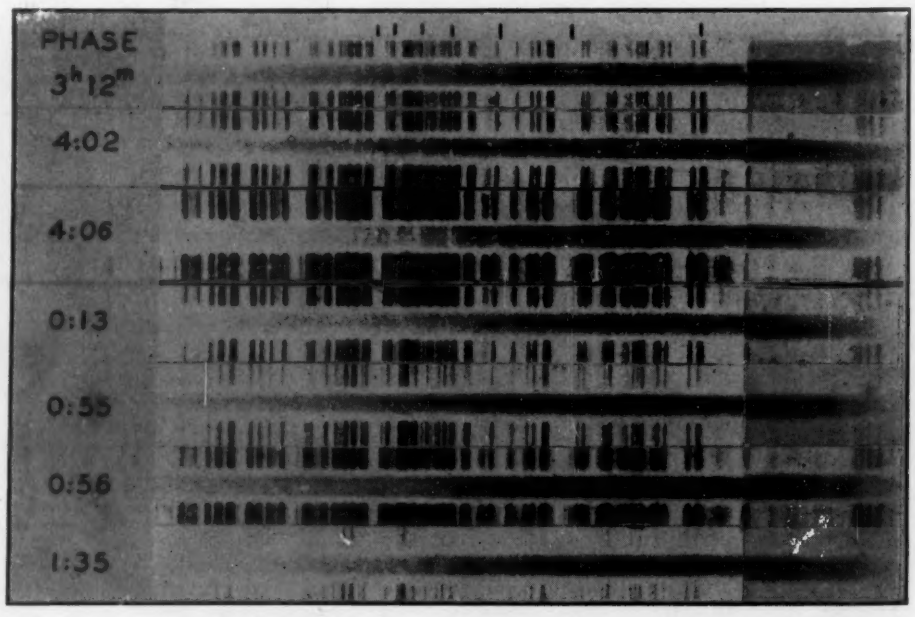


Fig. 3. The Balmer lines show in absorption (light on the negative reproduction) at phases 3:12, 4:02, and 4:06. The middle of primary minimum is phase 0:00, after which the spectrum is continuous, as shown in the four lower spectra (except for the emission in Fig. 2). Photograph courtesy Yerkes Observatory.

*Atomic Energy Commission predoctoral fellow.

Through the kindness of Dr. Struve, we are able to reproduce prints of the spectra he obtained. (Figs. 2 and 3.) The spectra differ greatly for corresponding times before and after mid-primary. Before eclipse, the Balmer series is quite strong in absorption, while at a symmetrical time after eclipse, there are no absorption lines, and $H\beta$ is present in emission. These peculiarities are undoubtedly correlated with the photometric anomalies which we describe below. What the nature of the correlation is, however, is at the moment little more than a matter for speculation.

At the instigation of Dr. Zdenek Kopal, secretary of the Panel on the Orbits of Eclipsing Variables, I undertook photoelectric observations as the ideal means of resolving the discrepancy between Krat's elements and those of Zverev and Kukarkin. A new photoelectric photometer for use on the 61-inch reflector at Harvard's Oak Ridge station was available. The star is well placed for observation during the spring.

Fig. 4. An arrow points to 13th-magnitude UX Ursae Majoris in a field of faint stars, enlarged from a photo by Harvard's 16-inch Metcalf telescope. North is at the top, east at the left.

On the night of February 23-24, this year, Ivan King† and I were able to observe the star continuously for about five hours, including two primary minima which occurred during that time.

The accompanying reproductions of the observing records may need a word of explanation. The output of the 1P21 photomultiplier tube goes to an amplifier, and from there to an automatic recorder. A chart runs through the recorder (Leeds and Northrup Micromax) at a constant speed. A pen draws a line whose distance from the chart zero is a direct measure of the light flux incident on the phototube. From time to time we measure the sky background, and we also monitor a comparison star to correct for changing atmospheric extinction. During primary minimum the variable changes much too rapidly to permit setting on the comparison star. The time covered by primary minimum is so short, however, that changes in atmospheric extinction during this interval are likely to be extremely small.

Fig. 5. A direct reproduction from part of the first night's observing record (February 23-24, 1949), showing the intrinsic light changes. D represents the dark current; S the sky background near the variable, measured with the same size of diaphragm as used for the star. C is a comparison star of constant brightness; UX represents the variable, for which the rapid fluctuations in light are unmistakable. Two large-scale divisions horizontally mark about five minutes of time (10 of the fine divisions); time progresses from right to left.

The faintness of the star prevented our using color filters, for, although we could have detected the presence of the star after passing its light through a filter, our precision of measuring would have been low. Consequently, the effective wave length of our measures is approximately 4200 angstroms, the wave length of maximum response of the 1P21. We had no provision for refrigerating the photomultiplier tube.

The first night's observing established two remarkable new phenomena which were totally unexpected.

First, the star is intrinsically variable, in addition to the light changes produced by its orbital motion. These intrinsic light fluctuations are of very short duration; they are not of constant amplitude or shape, and are very widely dispersed about an average period. It would be somewhat questionable to maintain that they are periodic at all. The amplitudes vary from as large as 0.11 magnitude to so small that they cannot be separated from the seeing fluctuations. Fig. 5, a section of the observing record, indicates the effect. A comparison of the constancy of the comparison star deflections with the changes in those of UX Ursae Majoris shows how unmistakable the effect is. As for the precision of measure, by far the largest noise contribution arises from seeing fluctuations. The signal-to-noise ratio for the variable on this night was about 75, leading to a probable error for a single measure of 0.0097 magnitude.

With the data presently at hand, the mean amplitude of the intrinsic fluctuations is 0.03 magnitude, and the mean period is four minutes. These results are of a very preliminary nature.

The second unexpected effect is an unusual asymmetry in the primary minimum. On going into minimum, the star behaves quite normally, but on coming out there is a "plateau" of constant light, starting at about phase 13.5

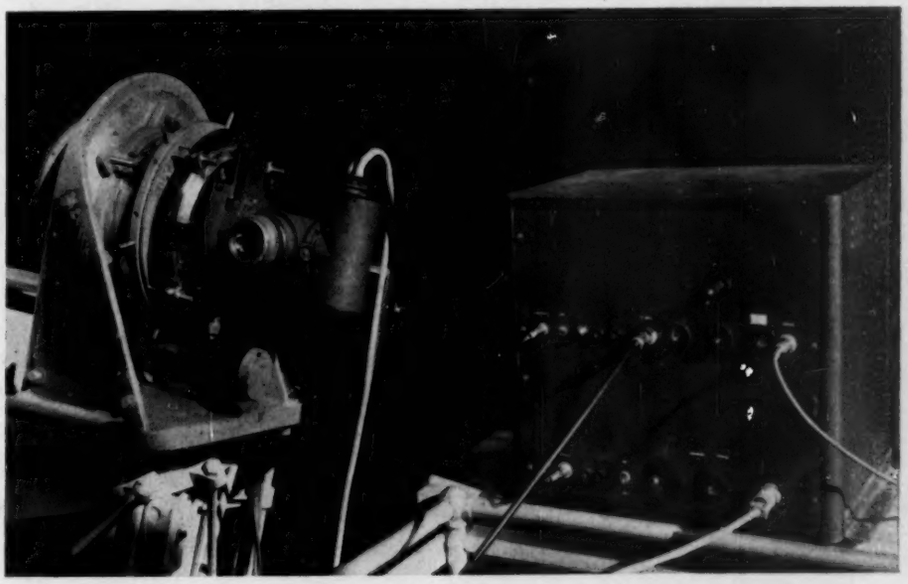


Fig. 6. The Harvard photometer (left) is connected to the amplifier case mounted on the observing platform of the 61-inch telescope. Photo by Robert E. Cox.

†Society of Fellows, Harvard University.

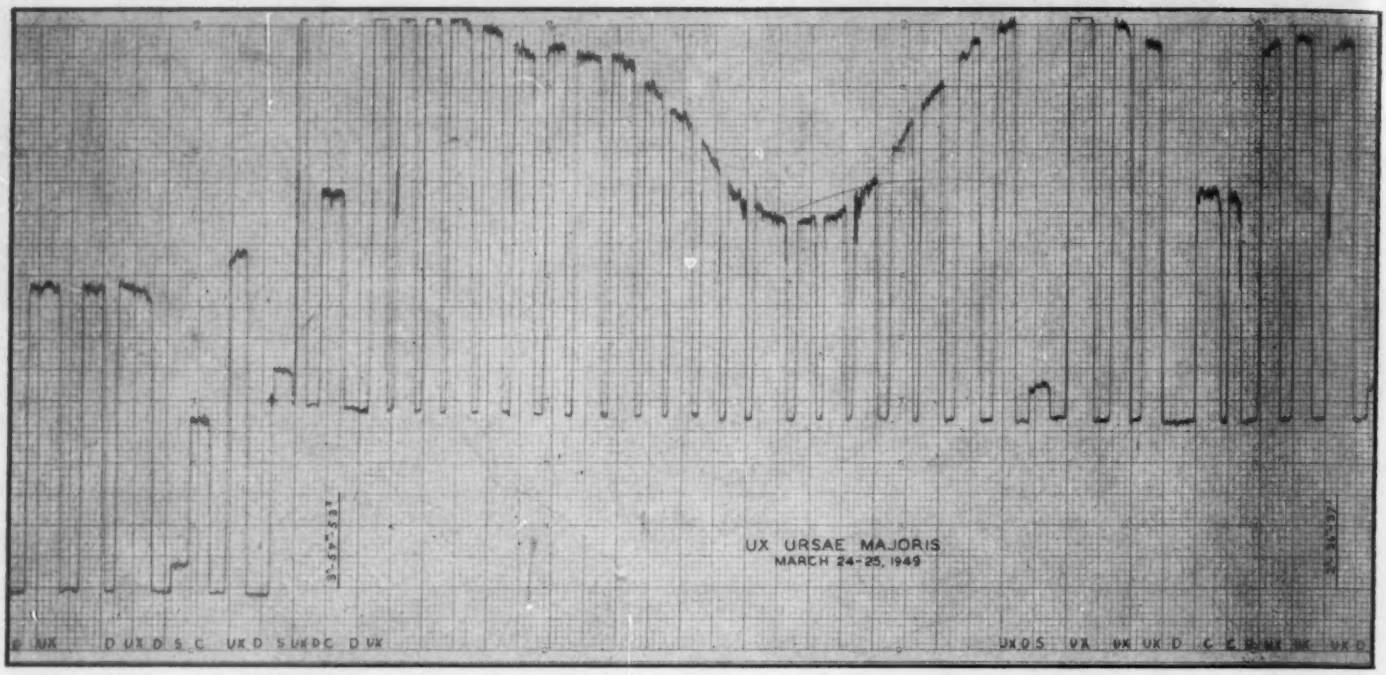


Fig. 7. Primary minimum on the night of March 24-25, 1949. Time progresses from right to left, same scale as in Fig. 5. Note the sudden increase in light before the minimum, sending the pen off the scale. The plateau on the ascending branch is pronounced. At about phase 23 minutes the star increased in brightness again, sending the pen off scale, and finally requiring a change in amplifier sensitivity at the point marked with a cross. D is dark current; S, sky background; C, comparison star.

minutes, lasting for about nine minutes, after which the brightness rises again. On the first night's observations, there was some indication of the effect, but comparison star measures came at rather unfortunate times. On the night of March 24-25, Bertram Donn‡ and I observed another primary minimum, and at this time the asymmetry was very apparent (Fig. 7). The pause on the rising part of the curve is unmistakable. At this time the brightness is about the same as that 40 minutes or more before the middle of primary minimum. After the plateau the brightness increases and remains anomalously high for 25 minutes. During this time it was necessary to change the amplifier sensitivity to bring the pen back on scale.

There are no indications of secondary minimum. However, it may be there, hidden in the intrinsic fluctuations. There are insufficient data at hand to make a decision now. If the intrinsic variations are associated with the *B*3 star, as seems likely, photoelectric observations in the red or infrared might disclose the secondary minimum. It is our intention to pursue the present series of violet observations for the remainder of this observing season. We plan to make infrared observations in the spring of 1950. Until we are able either to measure a secondary minimum, or to say with certainty that it is less than 0.01 magnitude deep, it is impossible to determine reliable elements for this system, except the period.

A new epoch, for the benefit of those who may be currently observing the star, is at J. D. 33011.84417. The period is 0.19667138 day, according to Krat. A corrected period will be determined later.

‡Atomic Energy Commission predoctoral fellow.

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[1]S. Beliavsky — NN.V.S. 4, 196 (42, 1933)
[2]M. Zverev and B. Kukarkin — NN.V.S. 5, 125 (53, 1937)
[3]W. Krat — Poulkovo Circ. *30*, 11, 1939
[4]G. P. Kuiper — Pub. A.A.S. *10*, 206, 1941
[5]O. Struve — Ap. J. *108*, 153, 1948

LETTER TO THE EDITOR

Sir:

I am a young Chinese astronomer deeply interested in astronomy, expecting to devote my whole life to the stars. I now work in the Institute of Astronomy, Academia Sinica (at the Purple Mountain Observatory, Nanking, now moved to Shanghai), and I am also secretary of the Astronomical Society of China. Your magazine is the best popular astronomical publication in the world — every star lover likes to read it.

In 1947, I had subscribed for the year 1948, but during this chaotic and distressed time in China I cannot make further payment in dollars to you. I beg you to continue sending me **Sky and Telescope,** for which I shall pay as soon as possible.

We have a new astronomical society in China, Star Club for Young Chinese, which we founded last year. Many members are students of astronomy in our universities, and we have several telescopes. Our observations of sunspots, the moon, planets, comets, and variable stars are reported bimonthly in a little publication, **Starlight.** But there are very few books and magazines on astronomy in this club, and we ask you to send us back numbers of The SKY and **Sky and Telescope** (before October, 1945) and as many other publications as possible. If you and readers of your magazine can help us we shall ever most gratefully remember your kindness.

LI YUAN
No. 88, Lane 275, Scott Road
Shanghai (5), China

Ed. Note: The cost of handling and mailing foreign subscriptions prohibits our acceding to requests of this kind. If a reader of the above letter wishes to make a gift to Mr. Yuan of a subscription we shall be glad to turn over to the donor the original letter with air-mail cover. Back numbers of **Sky and Telescope** are being sent to the Star Club for Young Chinese.

BACK ISSUES WANTED

Copies of Sky and Telescope for the months noted here are needed to fill subscribers' requests. For each copy received in good condition we will pay in stamps as follows: 25 cents each for December, 1941; January through June, August, September, 1942; November, December, 1943; January, November, December, 1944. 20 cents each for January, February, April, June, 1945; January, 1946. 15 cents each for February, September, 1948; January, February, 1949.

Place your full name and address carefully on the package in which magazines are shipped, so that refund may be made without the necessity for you to write a separate letter. Address magazines to Circulation Department, Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass.

A Simple DC Photometer for Photoelectric Photometry

By John S. Hall* and John F. Jewett, *Amherst College Observatory*

AT LEAST three excellent papers on general techniques of photoelectric photometry of the stars have been written by Dr. Gerald E. Kron, of the Lick Observatory.[1] The first two of these should be of particular interest to amateur astronomers, and their contents should be familiar to any readers of the present article who wish to consider constructing photoelectric apparatus of this type. Our purpose is to describe a simple battery-operated amplifier.[2] When this amplifier is used with a 1P21 photomultiplier, it has been found possible to obtain accurate results.

The photometer has two components. One houses the photomultiplier and is mounted at the eye end of the telescope. The other is a metal carrying case containing the amplifier with associated batteries, the batteries for the 1P21, and a microammeter. Ten insulated wires and a shielded cable connect these two components. The photomultiplier with its housing and associated cables need weigh no more than two or three pounds. The other parts are contained in the carrying case (9 x 7 x 15 inches) and weigh 30 pounds.

In order to conserve battery power three miniature tubes are used and no attempt is made to employ balanced circuits. Despite this fact, the zero drift of the output current is not objectionable and is usually less than the observed drift due to the slowly changing dark current of the photomultiplier. These two drifts are in opposite directions.

Observing Program

It is not possible at this time to outline a program that would be most suitable for a particular observer. Much depends on the aperture and location of his telescope and how careful a job has been done in building his photoelectric photometer.

One author (Hall) will be glad to suggest a suitable program to any amateur who has a photoelectric photometer that he has carefully constructed. It is suggested that such a photometer first be calibrated by the observation of a number of stars of similar color whose magnitudes have been accurately determined. The stars in the Pleiades are excellent for this purpose. Before a program can be properly specified, it is important to know:

1. The limiting magnitude attainable with the equipment at hand.
2. The results of the calibration runs suggested above.
3. The latitude of the observer.
4. The elevation (very roughly) and local conditions (such as the presence of smoke, fumes, and the like).
5. The peculiarities of the observer. How much observing he is willing to undertake. This is most important.

There are many objects brighter than 6th magnitude which should be observed regularly and accurately. These include several eclipsing stars and many irregular variables. If one can measure stars as faint as the 8th magnitude this field is greatly broadened. One can then also observe satellites, asteroids, and occasional novae. We believe that the field of photoelectric photometry is one in which the amateur can make a very substantial contribution to astronomical progress.

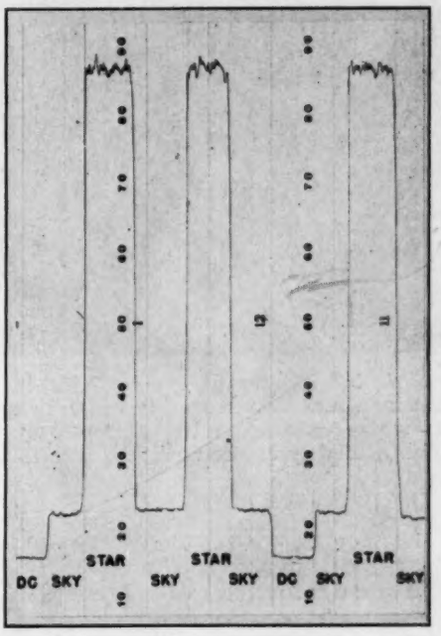


Fig. 1. The deflection produced by a 9th-magnitude star when the photometer was used in conjunction with the 18-inch refractor at Amherst. The large sky background deflection was caused by moonlight.

Performance

The performance of this amplifier is limited by the signal-to-noise ratio of the photomultiplier. We are not sure,

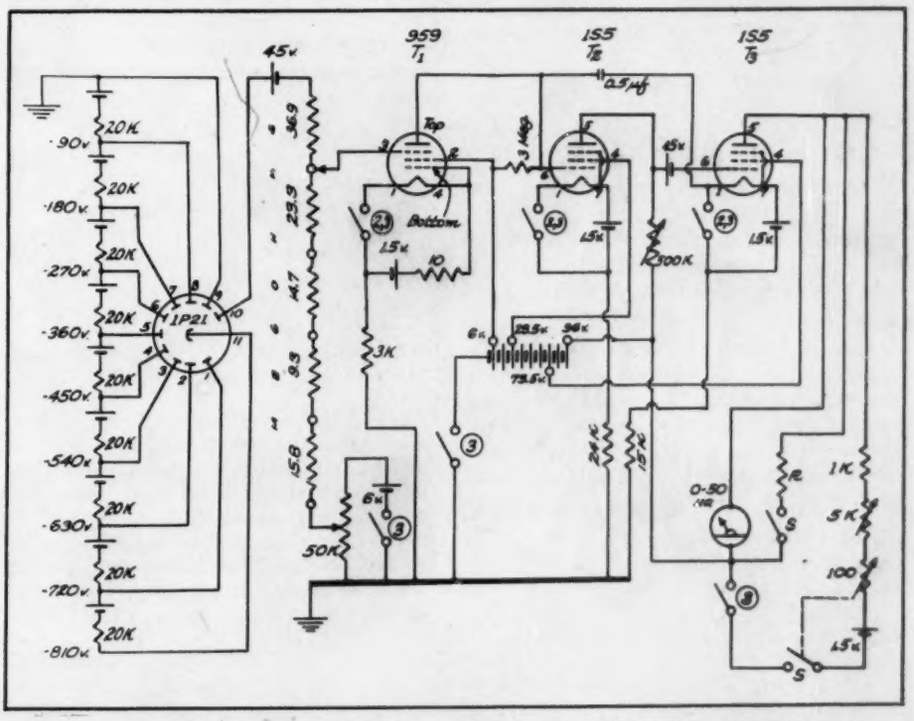


Fig. 2. The circuit diagram of the amplifier. The 20K (½-watt) resistors in the 1P21 circuit are for the protection of the user. The following resistors or potentiometers should have a 2-watt rating: 50K, 3K, 24K, 15K, and 500K. The others can be smaller. "R" should be 50 or 100 ohms. All switches except "S" are combined into a 6-pole, 3-position switch. The notation beside each switch shows for what switch positions that switch is closed. The short line on all batteries is the negative (—) terminal.

*Now at the U. S. Naval Observatory.

[1] "The Construction and Use of a Photomultiplier Type of Photoelectric Photometer," Bulletin #4 of the Panel on the Orbits of Eclipsing Variables (December, 1946); reprinted in Harvard *Circular* 451, January, 1949.
"Popular Photometry," *Sky and Telescope*, October, 1947.
"Electronics in Astronomy," *Electronics*, August, 1948.

[2] This amplifier was briefly described before the Northeast region of the Astronomical League at New Haven, Conn. (*Sky and Telescope*, 7, 177, 1948.)

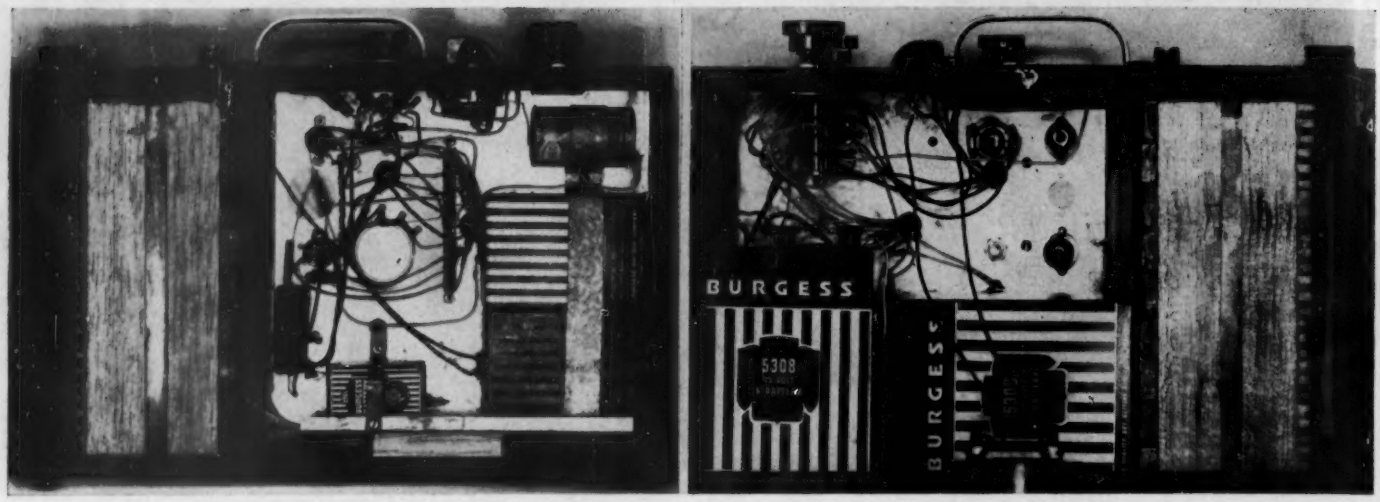


Fig. 3. The internal arrangement of parts. At left, the chassis, 7 x 9 x 2 inches, is mounted against the near border of the carrying case. The 500K potentiometer is shown near the center of that side; there is no external adjustment for this element. At right, the other side is shown. It contains three miniature tubes, the on-fil-off switch, and batteries. The three filament batteries are not visible, as they are between the two 5308's and the chassis.

however, to what extent this would be true if the noise of the photomultiplier were reduced by cooling with dry ice.

The deflections caused by a 9.0-magnitude early-type star are shown in Fig. 1. The 18-inch refractor at Amherst College was used. Similar results could have been obtained with a 7.5-magnitude star and a 9-inch telescope or with a 6.0-magnitude star and a 4½-inch telescope. The effect of sky background (moonlight in this case) is represented by the difference in deflection of the "SKY" and "DC" or dark current. A similar deflection would be produced by an 11.5-magnitude star. The zero level of the readings is arbitrary and full-scale deflection represents a change in output current of 50 microamperes.

Cost

The cost of the batteries required for the amplifier only is about $8.00. The three filament batteries may have to be replaced twice a year. Our amplifier has now operated satisfactorily for 150 hours with no replacements. The batteries for the photomultiplier cost about $25.00 if bought from a radio wholesaler. Smaller, hearing-aid batteries cost more. If these batteries are given proper care, they should last at least two years.

The most expensive single item is $50.00 for a 1P21 tube. Another expensive item is a meter. A 0-50 microampere meter having at least a 5-inch scale and calibrated to ½ of 1% is recommended. The cost, depending on the size and accuracy of calibration, may vary from $25.00 to $50.00. At least one manufacturer has offered to recalibrate a meter (regularly calibrated to 2%) to ½ of 1% for a few dollars extra. The cost of all remaining parts of the amplifier is about $50.00.[3]

Instructions

One of the authors (Jewett) will be glad to assume the responsibility of advising any interested amateurs on the technical details of construction and alignment of amplifiers built along the lines described in this article. The following instructions should be of considerable value to anyone building his own apparatus.

Construction. We make no claim that either the circuit presented in Fig. 2 or the arrangement of the parts shown in Figs. 3 and 4 cannot be improved. The placement of the parts is not particularly critical; the important factors are the reduction of leakage currents and the operating convenience of the finished amplifier.

The input circuit must be so arranged that the photocurrent which flows through the shielded cable and 45-volt battery passes to ground through the string of high resistors only. Care should be exercised in the mounting, wiring, and moisture-proofing of the input circuit (everything from pin 10 on the 1P21 to the plate of the 959). The shielded lead from the 1P21 to the amplifier should have extremely low leakage; the commonly available coaxial cables (such as RG 8/U) with polyethylene dielectric are quite satisfactory. Within the amplifier itself a high-grade plastic-insulated wire should be used. The input selector switch should have good insulating properties and the input resistors may be mounted directly on its terminals. Trouble from spurious leakage to ground is most apt to occur when the air is very humid.

The high resistors can be so chosen that each step represents a difference of half a magnitude. Then, if star A produces the same meter deflection as star B when the contact switch is on step 5 for A and on step 4 for B, A would be 0.50 magnitude fainter than B. Since high resistors of low tolerance are expensive, cheaper carbon resistors can be used and the actual value of each step determined by carefully noting the ratio of the deflections when the same star is observed at two different steps. In doing this, several stars of differing brightness should be chosen so that only the upper portion of the meter scale is always used for checking any two steps. There is no need for these steps to correspond exactly to half magnitudes. The process of heating a carbon resistor with a soldering iron will often change its value radically.

The B batteries for the photomultiplier are covered with melted ceresin wax (beeswax should do) and are surrounded by a wooden frame. The 959 should always be mounted either vertically or with the plane of the electrodes in a vertical position.

The batteries listed in Table I, or their equivalent, have been found to work well in our amplifier. Its size and weight could have been considerably reduced if smaller 45-volt batteries had been used in place of the 20 XX 30E's.

Alignment. If the circuit is wired correctly any difficulties in the initial align-

[3]The John F. Jewett Company, Amherst, Mass., can arrange to build amplifiers for any amateur astronomers or groups who do not feel competent to do the work themselves. A *preliminary estimate* of the price is $175.00 to $200.00 for the amplifier proper, including all batteries and tubes, but not including the multiplier tube or its mounting.

TABLE I. Batteries Required

Position	Designation (Mfg.'s number)	Quantity needed	Voltage of each
Filaments	Eveready 742	3	1.5
Plates and screens, T_2 and T_3	Burgess 5308	2	45
Plate and screen T_1	Burgess 5540	1	7.5
Grid circuit T_1	Burgess 422	2	3
Microammeter	Flashlight cell (large)	1	1.5
1P21 (pin 10)	Burgess XX 30E	1	45
Grid bias T_3	"	1	45
1P21 dynodes	"	18	45

ment can usually be traced to the tubes themselves. We have found that the variations in the characteristics of the 959's may be considerable in this mode of operation; the plate voltage and consequently the balance in the rest of the amplifier may vary markedly with different tubes. A careful study of the characteristics of these tubes has been made by Nielsen (**Review of Scientific Instruments, 18,** 18, 1947).

It is recommended that anyone building this amplifier procure a multimeter with a sensitivity which corresponds to 20,000 ohms per volt for the purpose of testing the amplifier. This multimeter could be used as the 0-50 microammeter in the output circuit. These meters, however, are bulkier and more difficult to read than a simple microammeter. The voltages specified in Table II were measured with respect to ground with such a meter (Simpson Model 260) after the balancing procedure described below had been used. Do not expect to obtain exactly the voltages shown in Table II; they are representative values only.

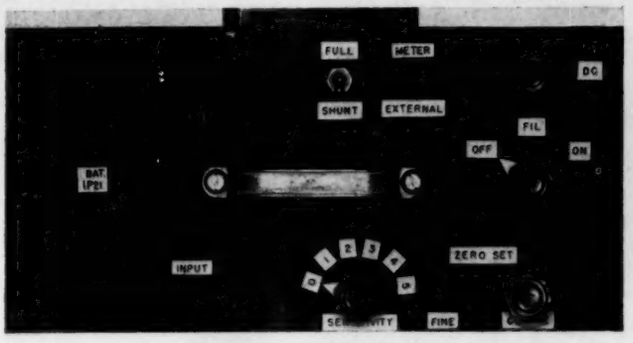


Fig. 4. Front view of the carrying case. The microammeter is shown at top center. The "input" is the coaxial cable connector for the signal from pin 10 of the 1P21 phototube.

TABLE II. Test Voltages
(20,000 ohms/volt meter)

Pin	T_1 (959)	T_2 (1S5)	T_3 (1S5)
1	1.1	2.2	17.8
2	6.0	—	—
3	0	—	—
4	2.0	28.5	73.5
5	2.0	*	96.0
6	—	2.9**	*
7	—	3.7	19.3
Top	2.9**	—	—
Bottom	2.0	—	—

*The voltages measured here will depend upon the individual characteristics of the tubes used.

**This figure was 3.6 when measured with an electronic voltmeter.

The amplifier may be balanced by the following procedure:

1. Set the "DC" control at the ground end of the 50K potentiometer. Substitute a 0-1 milliammeter for the 0-50 microammeter in the T_3 plate circuit. Leave the 100-ohm zeroing control in the off position so that the switch ganged with this control is open.

2. Adjust the 500K potentiometer in the plate circuit of T_2 to obtain an output milliammeter reading of 600-800 microamperes. If this is impossible try another 959 and then, if necessary, change T_2 or T_3. Until recently at least it has been possible to procure 959's from war surplus. It is advisable to have one or two spares of each type of tube used in the amplifier.

A change of 0.15 volts on the input grid of the 959 should produce a change of about 50 microamperes in the plate circuit of T_3. The output current has been found to be very closely linear with input voltage over this range.

Maintenance. Tubes are most easily checked by substituting new ones. The usual sort of "tube tester" of the emission type, used by most radio servicemen, may give very misleading information.

As the batteries approach the end of their useful life, the symptoms may be: increasing instability of the zero point; decreasing sensitivity; shift of zero point outside the range of the zero-set controls. The condition of batteries may best be tested roughly by comparing their voltages under open-circuit and load conditions. The open-circuit voltage of the batteries should not be smaller than 90 per cent of the nominal voltage. To check the voltage under load conditions, connect resistors across the battery terminals (20K ohms for 45-volt batteries, 3K for 6-volt batteries, and 25 ohms for 1.5-volt batteries). The battery voltage should not decrease more than 5% with the resistance connected as load on the battery. Do not check the multiplier batteries in this way: open-circuit voltage is an adequate test for these small batteries.

If all batteries and tubes are good, any remaining troubles can be found with a multimeter.

Operation. The operation of the instrument is quite simple. Initially the following conditions should exist. (The 100-ohm zero-control switch should always be left on after the alignment procedure has been completed.)

1. On-fil-off switch — off position.
2. 1P21 — no illumination — plug in its batteries.
3. Meter switch — shunt position.
4. DC potentiometer — so set that the lower end of the string of high resistors is at ground potential.
5. Sensitivity switch — 0 or ground position.
6. The on-fil-off switch should be turned to the on, or number 3 position, after a few seconds delay at the fil, or number 2 position. The meter pointer should then be set to zero by means of the "zero set" knobs; with it in this position the meter switch should be turned from shunt to full. When the sensitivity switch is turned successively to positions of higher sensitivity, the needle may deflect increasingly to the right. If the 1P21 is not connected to the input to the amplifier at this time, this deflection is due to grid current in T_1 and may be as great as 20 microamperes at highest sensitivity. If the 1P21 (not illuminated) is connected at this time, the meter deflection will be much larger because of the leakage current of the photomultiplier. This leakage is usually much less after the 1P21 has been connected for several hours. The DC control in the grid circuit of T_1 should always be used to make this meter read zero again. When light is allowed to strike the cell the resultant meter deflection should now be proportional to the light intensity.

ED. NOTE: This article is published with the sanction of the Technical Advisory Council of the Astronomical League.

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evenings, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill. Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday and Thursday at 8:30 p.m.; Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Curator, Gordon A. Atwater.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: 3 and 8:30 p.m. daily except Mondays; also 2 p.m. on Saturdays, Sundays, and holidays; 11 a.m. Saturdays, Children's Hour (adults admitted). Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. (Closed July to mid-September.) Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Tuesday and Sunday, 4 p.m. Special showings by request. Admission free. Spitz projector. Director, Ernest T. Ludhe.

Amateur Astronomers

THE JUNIOR ASTRONOMY CLUB OF CLEVELAND

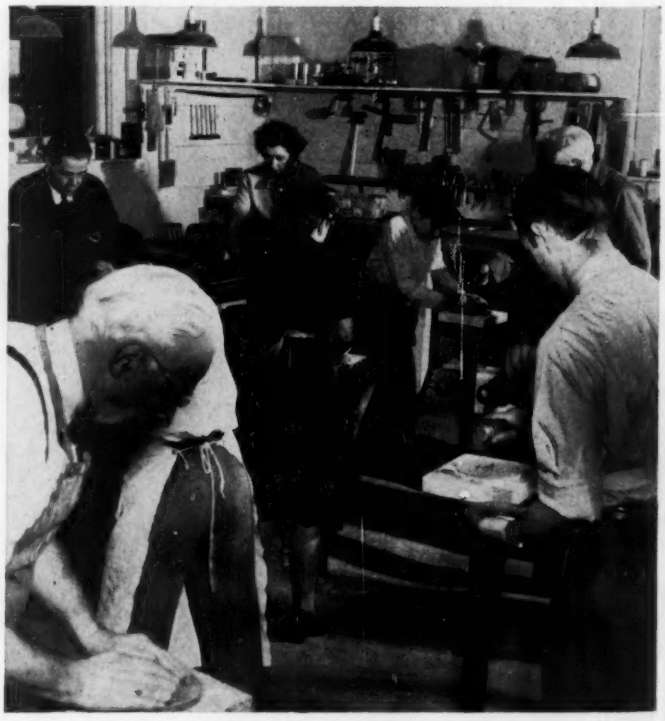
TELESCOPE MAKING in Cleveland has received great impetus this spring. Late in March the Junior Astronomy Club, sponsored by the Cleveland Astronomical Society and the Cleveland Museum of Natural History, with the co-operation of the science division of the Cleveland public schools, had 145 mirror makers working hard in classes conducted by several amateurs under the guidance of James L. Russell and Norman G. Bluhm. Any boy or girl of high school age may join the club proper, whose officers are juniors, with adult advisers only.

The museum has provided the club with two large rooms at 2717 Euclid Avenue, in the former carriage house at the rear of the museum proper. The meeting hall seats 250 persons, and the laboratory can hold 16 to 22 workers. Tools and machinery were furnished, and upright pipes were set into the floor and topped by flanges supporting 10-by-10-inch blocks to serve as grinding tables. When a telescope maker is finished for a class session, he unscrews the block and takes the entire unit home with him. The next student uses the same pedestal for his work. The telescopes are all 6-inch reflectors, with a straight wooden back instead of a tube. To facilitate instruction, focal length and other characteristics were standardized.

Mr. Russell reports that it was expected some members of the classes would drop out, but that they have all stayed and about 20 per cent more have applied for space at the grinding tables. Classes are held on Wednesday and Friday evenings, Saturday morning, and Sunday afternoon. One group is for older juniors and adults, so that no one might be denied the opportunity to make a telescope in the new shop. The only charge has been for materials, and any worthy student without finances may receive a helping hand in this matter also.

An innovation in the Junior Astronomy Club program is a section for those who wish to assemble war surplus binoculars under supervision. Another group is assembling surplus lenses into telescopes costing as little as two dollars. Some of the younger juniors are being steered into this endeavor before tackling the job of grinding mirrors. The entire club membership meets once a month in the auditorium to see movies, hear lectures, and engage in other activities.

Future plans call for the installation of screw-cutting machinery, a forge, a furnace for melting metals, and other equipment for making complete telescopes. On the activities side, variable star and comet-observing groups may be organized.



(Above) In the Junior Astronomy Club's workshop at the Cleveland Museum of Natural History, Norman G. Bluhm demonstrates the technique of mirror making.

(Right) A corner of the workshop of the Junior Astronomy Club. The next general meeting of the club is on May 22nd, at 4 p.m.

ASTRONOMICAL PHOTOGRAPHY HONORS

In the Third Michigan International Exhibition of Nature Photography (**Sky and Telescope,** December, 1948, 44), Carl P. Richards, of Salem, Ore., was given the Detroit Astronomical Society's award for the best print entry for his picture, "Jupiter and the Moon in Conjunction." His other three entries, two astronomical and one geological, were also accepted for exhibition. Mr. Richards is treasurer of the Astronomical League.

Four accepted entries were sent by Claude B. Carpenter, of Wayne, Mich., of astronomical subjects taken with his 12½-inch telescope. Emil Pearson, Red Granite, Wis., won recognition with four photographs entitled, "Flash," "Aurora Borealis," "Black Lightning," and "Star Trails." Of 324 entrants from 34 states and 14 foreign countries, 214 contributors had at least one entry accepted. The exhibition will be on view in various places in the Detroit area.

OBSERVATION NIGHTS IN WASHINGTON

Since 1945 the National Capital Parks (part of the National Park Service) has included astronomy observation in its series of outdoor programs. Eight observing evenings, in Rock Creek Park at 16th and Colorado Avenue, N. W., are on the schedule this year. The first was in April, and future dates are: May 8th, June 19th, July 31st, August 14th, September 18th, October 22nd and 30th. Four sessions are being devoted principally to the moon and planets, and four are called "star observation outings."

Lantern slides, through the use of portable power supply, and astronomical talks will be on the program if it is cloudy. For all the past programs, U. S. Lyons, of the Naval Observatory, and a member of the National Capital Astronomers, has been commentator, and members of the NCA have helped by providing telescopes.

Cleveland Exhibit Rules and Convention Notes

TELESCOPES and associated instruments will form a major part of the exhibit at the general convention of the Astronomical League in Cleveland, July 2-4. The convention committee hopes for at least one entry from every member organization in the league. Awards will be made in the following classes:

Class 1. Best-constructed instrument, taking into account nicety of arrangement, finish, machine work, completeness, and so forth.

Class 2. Instrument giving the best optical performance.

Class 3. Best advanced instrument (camera, Schmidt telescope, solar filter, or other especially meritorious instrument or device).

Class 4. Best instrument of any type constructed by a junior 18 years of age or under.

Class 5. Best display in other fields than instruments.

Exhibit Rules

1. Requests for exhibit space, together with the entry fee, must be forwarded to Leo Schoenig, 825 Tripoli St., Pittsburgh 12, Pa., not later than June 15th. The class or classes in which material is to be entered should be stated. The entry fee is $1.00 for each large exhibit (such as a telescope), and 50 cents for a small exhibit (photograph, chart, etc.).

2. Exhibits must be brought to the convention by the entrant or another person, and are not to be shipped or mailed. They will be accepted after noon on Friday, July 1st, and all apparatus and displays must be set up not later than the afternoon of July 2nd. Experienced personnel will be on hand to help arrange the display. Each exhibit should be identified by a 3-by-5-inch card affixed securely. Every effort will be made to safeguard exhibits, but all risks are the responsibility of the owner.

3. All instruments entered must be made by the entrant. This condition shall be deemed to have been met if either the objective or mirror, or the mount, or both, have been made by the contestant, even though purchased parts have entered into the construction.

4. Instruments entered for the award in optical excellence must be set up outdoors on the evening of July 2nd during the star party, and be available for the inspection of the judges at that time, complete with all accessories to be used.

5. Apparatus entered for the award for advanced construction need not be set up for use, but specimen photographs or samples of work done with it may be submitted as evidence of performance.

6. Exhibits submitted for any award, including the junior award (Class 4), may be entered in other classes as well.

7. Photographs and charts should measure at least 5 by 7 inches, and bear the exhibitor's name and address on the reverse side. An explanatory note should be attached to the lower margin, and should include the name of the exhibitor.

Instruments Clinic

Are you having telescope troubles? Is your particular pain in your declination axis, your eyepiece, or your mounting? Expert consultants to help cure your instrument ailments will be available at the instruments clinic, to be held in connection with the exhibit at the convention. Whenever the convention is not in session, you will find these consultants at the exhibit headquarters, eager and willing to talk over your problems. Bring your partially completed mirrors, your eyepieces, your mountings, for examination. It is planned to set up equipment for demonstrating the best grinding and polishing techniques, and Foucault light tunnels so you can see your mirror under test. The instruments clinic is designed to help you in every way possible. Plan to make use of it while you are attending the convention.

Convention Program

Details of the program are being worked out by Royce Parkin, Cleveland Astronomical Society, Charles H. LeRoy, chairman of the Middle East region, and R. R. LaPelle, activities chairman of the league. Mr. LaPelle is planning to have one or two invited papers at each session of the section meetings, followed by an open meeting to permit questions and general discussion.

Amateurs wishing to present papers must note that May 21st, six weeks before the convention, is the closing date for submission of titles and brief ab-

(Continued on page 185)

THIS MONTH'S MEETINGS

Chicago, Ill.: Following impromptu talks on the May evening sky, the Burnham Astronomical Society at its May 10th meeting will hear a lecture by Dr. K. Aa. Strand, Dearborn Observatory, on "The Masses of the Stars." The meeting is in the Chicago Academy of Sciences at 8:00 p.m.

Cleveland, Ohio: "The Lick Observatory and Its Work" will be discussed by Dr. Gerald Kron, of Lick Observatory, at the May 27th meeting of the Cleveland Astronomical Society, 8 o'clock at the Warner and Swasey Observatory.

Detroit, Mich.: The Detroit Astronomical Society will meet on Sunday, May 8th, at 3 p.m. at State Hall, Wayne University. Dr. Eugene Walker, University of Michigan, will discuss "Glaciers and Climatic Changes." Dinner to honor the guest speaker will follow the lecture.

Geneva, Ill.: On Tuesday, May 3rd, a symposium on light will be held by the Fox Valley Astronomical Society, meeting at 8 p.m. in the Geneva City Hall. "Theories of Light" will be discussed by Carl Bast; "Nature and Properties of Light," by Clarence R. Smith; "Dispersion and Reflection," by Frank Hancock.

Indianapolis, Ind.: On May 1st the Indiana Astronomical Society will hold its annual "Sky Information Please," conducted by the board of officers, at 2:15 p.m. in Cropsey Hall.

Kalamazoo, Mich.: The Kalamazoo Amateur Astronomical Association meets on May 21st at 8:00 p.m., at the home of Mr. and Mrs. Hans Baldauf, 1221 Warren Place. William Persons will speak on "Light," and Edgar Pashby on "Radar and Its Applications to Astronomy."

Los Angeles, Calif.: The Los Angeles Astronomical Society, meeting May 10th at 7:45 p.m., in the Griffith Observatory, will hear William Hoeppner, of the Hoeppner Optical Glass Manufacturing Co., speak on "Manufacturing Optical Glass."

Madison, Wis.: "Comets," "Meteors," and "Asteroids" will be discussed by Charlotte Stewart, Bob Burkhalter, and Lawrence Demmer, respectively, at the May 11th meeting of the Madison Astronomical Society, 8 o'clock in the Washburn Observatory.

Minneapolis, Minn.: Dr. S. R. B. Cooke will speak on "The Newer Astronomical Instruments" at the May 4th meeting of the Minneapolis Astronomy Club, held in the Minneapolis Public Library at 7:30 p.m. A picnic supper and field trip are scheduled for May 18th.

New Haven, Conn.: At the annual meeting of the New Haven Amateur Astronomical Society on May 28th, Professor Margoneau will discuss "Astronomy and Psychology." The society is now meeting at the Hall of Graduate Studies at 8 p.m.

New York, N. Y.: The Amateur Astronomers Association will hold its annual meeting on May 18th, at the American Museum of Natural History at 8 o'clock, when there will be motion pictures, reports of officers and committees, elections, and entertainment.

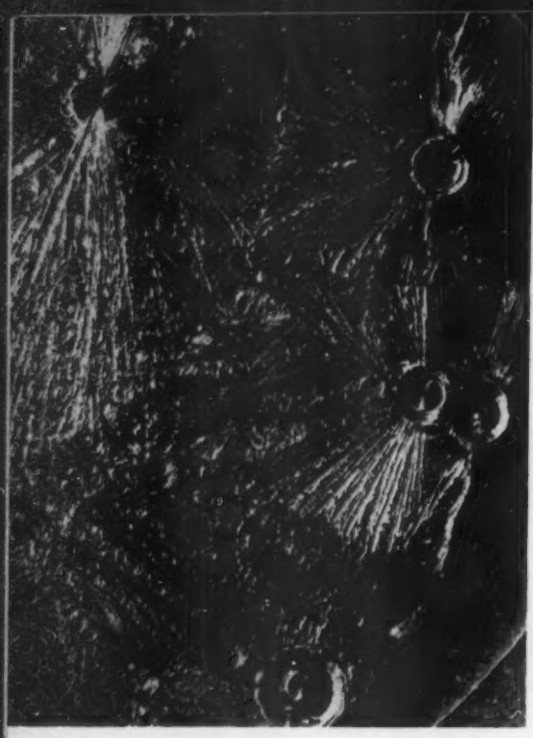
The annual jubilee of the Junior Astronomy Club will be on May 27th, 7:30 p.m., at the American Museum of Natural History.

Philadelphia, Pa.: Dr. Edgar W. Woolard, of the Nautical Almanac Office, will speak on "Impress of Past Ages on Modern Astronomy" at the May 13th meeting of the Rittenhouse Astronomical Society, 8:00 p.m. in the Randal Morgan Physics Laboratory, University of Pennsylvania.

Pittsburgh, Pa.: On Friday, May 13th, Glenn Winterhalter will lecture on "Stellar Photography at the Allegheny Observatory," before the Amateur Astronomers Association of Pittsburgh, in the lecture hall of the Buhl Planetarium at 8:30 p.m.

San Diego, Calif.: The May 6th meeting of the San Diego Astronomical Society, in the Gas and Electric Building at 7:30 p.m., will be membership night. Six members will speak on various phases of astronomy, and Professors W. T. Skilling and B. O. Lacey will answer questions.

Washington, D. C.: Paul Watson, of the Maryland Academy of Sciences, will speak at the meeting of the National Capital Astronomers on May 7th at 8:15 p.m. in the Commerce Department auditorium. His subject is "In the Depths of Space."



Laboratory Craters

IN THE COURSE of laboratory investigation of a certain organic compound on November 16, 1948, we observed a solidification phenomenon which produced a pockmarked surface strikingly similar to that observed on the surface of the moon. The accompanying photograph shows a part of this sample, which is stable and has been preserved.

The phenomenon was produced by drying a small amount of this molten compound on a watch glass for three hours at 100° to 105° C. in an electrically heated oven. Then the sample was set in a desiccator where it cooled, for about one hour, down to room temperature without solidifying. Since this material has a normal solidification point of about 70° C., it is evident that extensive supercooling occurred. On removing the sample from the desiccator and setting it momentarily on a stone table top, prior to weighing, rapid crystallization took place, forming within the space of a minute or so the peculiar surface appearance shown in the photograph.

The spectacular crystal growth, which was accompanied by sharp, crackling sounds, was so remarkable that the analyst, Miss S. Dolgin, called it to the attention of my colleague, F. Megson, and myself. Shortly afterward, while discussing this most remarkable laboratory phenomenon, we thought of the many features the sample and the lunar surface appear to have in common:

1. The craters are circular. 2. The rims are elevated slightly above the average plane. 3. The craters are surrounded by long and intimately associated radial lines. 4. There are central peaks in some craters and flat elevated plateaus in others. Each of the craters differs markedly in detail. 5. Their distribution is at random. Most of the craters are single but one pair was formed. 6. The ratio of diameter to depth, although not measured, appears to be roughly proportional to such ratios on the moon.

These miniature craters seem to have been formed by a chance combination of crystallization and contraction effects as the result of extensive supercooling initiated quite possibly by minute dust particles. Attempts to reproduce this effect in the laboratory were unsuccessful, suggesting that the exact conditions necessary are quite critical. We have not before seen nor heard of a similar phenomenon.

Perhaps some of the craters on the moon were formed by meteoritic impact on a critically supercooled surface. It is significant, we think, that in the laboratory minute dust particles could act to produce such enormous craters. It suggests that the impact of a rather small meteoritic particle might, in like manner, initiate the release of latent but powerful solidification forces on the moon and result in a crater the size of which would be out of proportion to that of the meteoritic particle or the force of its impact. Meteoritic impacts prior to this critical period would not have formed craters because they would be absorbed by the semiplastic mass of cooling rock; subsequent impacts would be quite ineffective on a solidified surface.

The possibility of crater formation by special solidification and/or crystallization phenomena may have been considered before, but could not be taken seriously without a specific example such as this. One would scarcely imagine, much less contend, that solidification could ever result in such strange forms. Since a specific example has been observed in miniature in the laboratory, it may now merit the attention of astronomical science and throw more light on this ancient problem.

S. I. GALE
Calco Chemical Division
American Cyanamid Company
Bound Brook, N. J.

Calendar for the Moon

AS AN amateur astronomer of irregular habits, I am often faced with the question as to when it may be a good time to look at the moon. Since an almanac or calendar with the phases may not always be available, I have prepared a table which is small enough to be carried in my wallet.

	1949	1950	1951	1952
January	6	25	14	4
February	5	24	13	2
March	7	26	14	3
April	6	24	13	1
May	5	24	13	1-30
June	3	22	11	29
July	2	21	11	28
August	1-30	20	9	27
September	28	18	8	26
October	28	17	7	25
November	26	16	6	24
December	26	15	5	23

This table presents those evening dates in the United States on which the moon will be near first quarter. The earlier date is chosen if first quarter occurs before Greenwich noon. As the dates for 1951 and 1952 are extrapolated, they may often disagree with actual dates of first quarter by one day and occasionally by two. In any event, the table will indicate the period each month when our satellite will be best placed for evening observation.

CHARLES E. BALLEISEN
633 Russell St.
West Lafayette, Ind.

MOON MI

Mexican Montage

THE PHOTOGRAPHS of the moon at first and last quarter reproduced here were made without a telescope! They are the result of patient and careful work in pasting together, fitting, and retouching the 18 plates of the moon published by **Sky and Telescope** from Lick Observatory negatives. The greatest trouble was matching up the different tones of some prints. If the Moon Sets were printed on mat paper instead of glossy, the retouching would be easier. Besides, some plates are of different scale, which makes the fitting more difficult. But my results seem satisfactory and may encourage other amateurs to try their luck.*

The detailed procedures to follow are these:

1. Cut the white margins off the plates, leaving provisionally the Roman number at the bottom of each.

2. Put the plates together, according to the key furnished with the set.

3. Hold them down with small pieces of glass.

4. Before making any cut, see which plate looks better on top of the one beneath.

5. Now cuts can be made on the top plates, across craters, mountains, and so on, **in zigzag lines** as required by the section to be fitted. In this way, the half of a crater on the top plate is matched by the corresponding half of the **whole** crater

*A similar experiment, in which the back-cover photographs of the first-quarter moon were mounted and rephotographed, was reported in the March, 1947, issue of **Sky and Telescope**, page 12.

The first-quarter moon: photograph of a montage of halftone reproductions made from Lick Observatory prints.

underneath. And having points of reference in this way, you can glue a very small portion of the top plate onto the lower, no matter how large is the portion of the hidden plate underneath. At this step, slight gluing should be done far from the edges.

6. Make a necessary cut only after taking a new plate to make it fit on the lower one, planning cuts well in advance of making them.

7. As the parts are pasted, the pieces of glass on top can be removed, and the Roman numerals cut off.

8. When all parts are together, paste the half moon by its edges onto a black cardboard. India ink will cover any white edges outside of the entire picture of the moon.

9. Now the final pasting can be done, only on the edges of the zigzag overlappings. I smeared a little glue on a piece of glossy waste paper from the plate margins, and ran it along and underneath the edge of the top plate, pressing the glued edge with the other hand.

10. Now comes the retouching. Pencil does not take on the glossy paper, so I used Higgins American India ink and white wash paint, weakened with water. Use a broad and a fine brush (Windsor and Newton), not wet, but only damp. The black and white must be mixed to make the proper tone.

11. To tone down some parts of the areas, a soft eraser can be used, but only very carefully, as it takes off the printing ink of the plates. Experiment first on a section of the picture that will remain hidden. (I think an airbrush could be used successfully, but didn't try it.) During this retouching, darken clear parts and whiten a neighboring dark space to produce uniformity of quality on overlapping pieces; even little peaks and craters have to be made to fit their counterparts.

12. Photographing the mosaic comes next. I took a 5 x 7 picture of each quarter, with indirect light to avoid shining of some parts (another inconvenience of the glossy paper).

13. Then the negatives have to be retouched, in the usual manner of studio work, still softening down some areas or lines either with pencil or etching knife. So that the lunar seas will not print too black, some water color (Eastman) carmine can be applied to the back of the film.

FRANCISCO VELASCO T.
Puente de Alvarado 30
Mexico, D. F., Mexico

Montage of the last-quarter moon. Senor Velasco's instructions for making the montages are given above.

LETTERS

Sir:

J. E. Spurr's recent book entitled **Lunar Catastrophic History** (Rumford Press, 1948) states that lunar craters originated from the bursting of bubbles. When the moon became fixed, constantly showing but one side toward the earth, the attraction of the latter was so great that it caused the surface of the moon to bulge. The heat generated by the attendant shearing and faulting was sufficiently great to melt and boil the surface. Some of the bubble domes, over a hundred miles in diameter, rose to a height of 40 miles before bursting and throwing out rims up to 20,000 feet high. There was no bulging or boiling on the side of the moon facing away from the earth. The fault system followed a master plan of a series of overlapping concentric circles with centers on the lunar equator originating at the centers of the two quadrants facing away from the earth, thus being radially asymmetrical.

Some points which the theory apparently does not explain are:

While the moon was revolving in relation to the earth, our planet exerted a pull upon the moon which caused a land tide from 50 to 100 feet high. When the moon became fixed, this tide "froze" with its highest point in the center of the moon as we now see it. In other words, the land tide on the moon is now stationary and bulges towards us no farther than it did while the moon revolved independently, that is, 50 to 100 feet out of true. Therefore, if the shearing due to land tide caused melting and boiling after the moon became fixed, it must have been just as hot while revolving.

Tides, either land or water, exist upon **both** sides of a sphere that is subject to pull from an adjacent sphere. Thus, the earth has a tide in the open ocean of 2½ feet on the side facing the moon and an equally high tide on the opposite side. This tide lags somewhat, but we also have a land tide of about 10 inches at the equator, facing the moon, and an equally high land tide upon the opposite side of the earth, with low tides between. As a consequence, the lunar land tide existed and the present "frozen" lunar tide still exists on the side of the moon facing away from us. If the moon bubbled on this side, it did so equally on the other.

Shearing and faulting caused by the attraction of the earth upon the moon would have followed a radially symmetrical pattern, if **any**, with foci at the nearest and farthest points respectively.

If moon craters were dependent upon earth pull, they should be largest where the tide was highest; that is, at the middle of the disk we see; and progressively smaller toward the edges where the tide was less. We can see 59 per cent of the surface of the moon, and there is no diminution in crater size at the "sides," or low-tide sections.

The nature of the gases which are supposed to have generated the bubbles is not mentioned. Bubbles in terrestrial volcanoes are largely of steam, but no water was supposed to have existed on the moon. Rock on the moon might turn into gas at possibly 4,000° or 5,000° F., but that gases "may be still rising" from a cold moon precludes a 5,000° origin of the gases.

There is no substance found on the earth having sufficient strength, cohesion, and elasticity to form a dome 40 miles high and over 100 miles in diameter, and at the same time be gasproof. There is no reason to believe that the moon possesses any substance which differs greatly from those found here.

Gas within a molten magma rises vertically in relatively small bubbles. If a surface crust exists, the gas tears rents and fissures, escaping in a stream instead of by explosion. If gas pressure would burst a giant dome, it would doubtless escape at many points of weakness, allowing the dome material to fall back into the crater instead of throwing out sufficient material to form 20,000-foot mountains.

The melting point of rock lava of about 2,000° F. would render the material too liquid to form a crust for a 100-mile-wide bubble. Cooling lava is notoriously brittle. If we assume a crust 50 miles thick (and at the same time remember that the faulting extended only a matter of a hundred feet deep), the weight of this burden would be about 7,920,000 pounds per square foot. (Rock weighing 180 pounds per cubic foot here would weigh about 30 on the moon.)

All of the above strictures are avoided by a theory of meteoritic origin of the craters, and of these the earth also received its proportionate share.

CHAPMAN GRANT
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San Diego 3, Calif.

CIVIL SERVICE POSITIONS

The Civil Service Commission has announced that applications are still being accepted for astronomer positions in Washington, D. C., and vicinity. Applicants must have completed a bachelor's course in astronomy or four years progressive technical experience or a combination, plus having had professional experience or graduate study. Salaries are from $3,727 to $7,432 a year. No written test is required. Application forms and full information are available direct from the U. S. Civil Service Commission, Washington 25, D. C.

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The Skalnate Pleso ATLAS OF THE HEAVENS, designed and executed by Antonin Becvar and his associates, should prove invaluable to all amateur and professional astronomers. One of the charts, on a reduced scale, was reproduced and described in the November, 1948, issue of *Sky and Telescope*.

The atlas is printed on 100-pound stock, each chart area 15½ by 23½ inches. A title page, descriptive matter and a chart key are included. The set is shipped rolled, in a heavy mailing tube.

$5.00 postpaid

SKY PUBLISHING CORPORATION
Harvard College Observatory
Cambridge 38, Massachusetts

BOOKS AND THE SKY

YANKEE SCIENCE IN THE MAKING

Dirk J. Struik. Little, Brown and Company, Boston, 1948. 430 pages. $5.00.

HERE IS a notable contribution both to the history of modern science and that of New England culture. Its author, Professor Struik of Massachusetts Institute of Technology, is a mathematician of high standing and at the same time a keen student of the interactions of science, technology, and the economic and social forces that so largely shape society. He writes with the detachment of one born and educated in Europe, but also with the friendly familiarity of one who has lived more than 20 years in New England, and evidently enjoys it.

The first words of Chapter I are: "In the year of the Lord 1620 Francis Bacon, Lord Chancellor to King James of England, published his **Novum Organum**." To many it will be surprising to recall that Harvard College had passed its first half century when Newton's **Principia** was published, and to learn that Boyle, Wilkins, and other founders of the Royal Society, by their own statement, might have emigrated to Connecticut "out of esteem for the most excellent and valuable Governor, John Winthrop the Younger . . . and there have established that Society for Promoting Natural Knowledge," had the Restoration of Charles II not taken place. The first century of the New England colonies was the century of Newton, Leibnitz, Huygens, and Pascal. Galileo, Descartes, and Harvey were alive when it began; Euler and Linnaeus were born at its close, and Lagrange, Lavoisier, and Dalton early in the second century. The new knowledge grew in the new community while it grew in the old world. Under frontier conditions, the restrictions of British colonial policy, and the exigencies of revolution and post-revolutionary crises, American science developed more slowly than European, and with a strong descriptive and practical emphasis. Philadelphia was the colonial center of science, but there were capable and active investigators of nature in Boston, Newport, New Haven, and elsewhere east of the Hudson. The New Englanders were a relatively homogeneous group with a characteristic culture, and until Civil War days a Yankee science really existed, not isolated from the South or from Europe, yet with its own quality.

The story of this Yankee science is here told in fascinating detail. The arrangement is by periods — colonial, Federalist, Jacksonian. Within each period various fields of inquiry and achievement are discussed in turn. Characteristic chapter titles are "The Practical Navigators," "Turnpike and Towpath," "Lecture Hall and Textbook," "The Surveys," "The Great Naturalists," "Sky and Ocean." Many familiar names appear: Bowditch, the Bonds, Eli Whitney, Agassiz, Benjamin Peirce. But many more are introduced who should be better known. We meet John Winthrop the Third, Hollis Professor at Harvard and probably the most distinguished of New England colonial scientists; Benjamin Waterhouse, professor, physician, naturalist, and political storm center; Eben Horsford, who gave up his professorship in chemistry at Harvard to devote full time to his Rumford Chemical Works, which still manufactures the baking powder he invented; Patrick Kerr Rogers and his four sons, all professors of science and one (William Barton Rogers) founder of Massachusetts Institute of Technology. Two chapters dealing with science in the colleges and scientific schools particularly interested this reviewer, as did also one on the cultural and humanitarian contacts of the sciences.

From all this detail, a consistent pic-

NEW BOOKS RECEIVED

BASIC OPTICS FOR THE SPORTSMAN, *Earle B. Brown*, 1949, *Stoeger Arms Corporation*. 259 pages. $4.00.

Designed to fill a gap in sportsmen's literature, this book covers principles of optics, optical instruments, and the care and selection of instruments, with particular attention to rifle and spotting scopes, binoculars, and cameras, but including telescopes and microscopes.

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ture emerges of Yankee science in its first two and a half centuries. It is widely disseminated among the people, appreciated and supported by them. It is strong in technological application, worthily contributing to natural history, botany, and geology, not without merit in medicine, chemistry, and astronomy, relatively weak in physics and especially in mathematics. It is a picture to be contemplated with both pride and humility, and we are much indebted to Dirk J. Struik for painting it with clarity and life.

B. W. SITTERLY
American University

THE HISTORY OF THE BRITISH ASTRONOMICAL ASSOCIATION

The First Fifty Years

Various authors. British Astronomical Association, Burlington House, London W. 1, 1948. 132 pages. 3s.

IN JULY, 1890, a letter in **English Mechanic** advocated the formation of an amateur astronomical association with headquarters in London. It was not to rival the professional Royal Astronomical Society but to be organized "primarily for those who found the subscription to the Society too high, or the papers too technical, or who, being women, were excluded." By October 24th of that year the first meeting of the British Astronomical Association was held, its membership having already risen to 283. When in 1942 the BAA moved into new quarters, its president, F. J. Sellers, suggested that both the move and the jubilee be commemorated by a history of the association's 50-odd years of activity. This history has now appeared as one of the **Memoirs** of the association, Vol. 36, Part 2. Many of the members took part in its compilation, but principally Mrs. John Evershed, FRAS, and Howard L. Kelly, FRAS, past and present directors, respectively, of the association's historical section.

One of the most spectacular things about this society's history is the membership chart indicating that the thousand mark was reached within five years of the inception of the organization, and that membership remained well within 200 of that figure until 1943. Then wartime blackout skies made people star conscious (during their vigilance in the interest of national defense), so that by 1944 the membership suddenly surpassed the 1,400 mark. The efforts expended by the officers to counteract the natural effects of various wars and the depression and to maintain their nearly constant membership are truly worthy of remark.

While a few sections of the history may read like abstracts from the minutes of meetings, the whole is very well planned to give a good picture of the history of astronomy (as well as of the association) during the period covered, with occasional entertaining anecdotes.

The members have always been active. Their work has been divided into 18 sections; for example, there are sections on solar spectroscopy, comets, meteors, the various planets, computing, and so on.

From the beginning the members of the sections organized observing programs or stimulated co-operative observations in their fields of interest. Thus there are good accounts of early eclipse expeditions, in 1896, 1898, 1900, and 1905. Only the first of these eclipses was completely clouded out; but the expedition proved the potentialities of the organization of eclipse parties. Another eclipse, April, 1911, was observed by only one member of the BAA on a government expedition, Father Cortie. His experiences must have been quite trying. Walker Island in the Pacific was ideally situated with respect to the eclipse path but "has a habit of disappearing beneath the sea at times, so it was thought wiser to avoid it." The island chosen, Vavau, experienced an earthquake while the eclipse instruments were being set up, "but this obligingly just shook into place one instrument which was not in perfect adjustment."

Meteor observing quite naturally attracted the early amateurs, especially when the Leonids of 1899 were prominently forecast by the press. During the Giacobinid display a few years ago observations from airplanes were widely hailed as modern advances. Yet as early as 1899 we find a BAA member, Rev. J. Bacon, with his daughter making an ascent by balloon in order to get the best possible view of the meteoric spectacle. Miss Bacon appeared at the following meeting with a fractured arm. Having drifted westward in the clouds, the balloon just escaped landing in the Bristol channel and ended its flight in an oak tree. Meanwhile a witty ex-president, the Irish Dr. Downing, reported that he "had retired comfortably to bed at the date in 1899 when the less instructed were sitting up in expectation of the Leonid showers which he had good reason to conclude would not take place."

Americans will appreciate the many cordial references to visits of our astronomers at meetings of the BAA — and smile with abashed humor at the reference to a British visitor in Chicago in 1915 who found he could obtain lantern slides of "English lakes, Anne Hathaway's cottage, temples in Egypt, palaces in Peking, or the Panama Canal, but the Yerkes Observatory was unknown!" We are confident our present-day pride has advanced to the extent that anyone here can tell the visiting Britisher how to get to Palomar.

DORRIT HOFFLEIT
Harvard College Observatory

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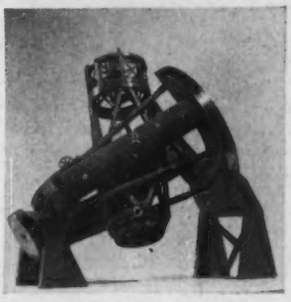

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Sky Publications

Cosmic Rays **50c**
Here is the story of the "mysterious and unseen but powerful visitors from space," graphically told, with some background in atomic physics. By W. F. G. Swann, director of the Bartol Research Foundation.

Relativity **50c**
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The authors are James G. Baker, Bart J. Bok, J. H. Dellinger, W. J. Eckert, Leo Goldberg, Jesse L. Greenstein, B. Haurwitz, Zdenek Kopal, Gerald E. Kron, Donald H. Menzel, R. M. Petrie, Walter Orr Roberts, Henry Norris Russell, Carl Schalen, Harlow Shapley, Lyman Spitzer, Jr., Joel Stebbins, Harlan T. Stetson, Otto Struve, H. C. van de Hulst, Fred L. Whipple, A. E. Whitford, H. C. Willett.

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TERMINOLOGY TALKS - J. Hugh Pruett

Transit, Occultation

The term *transit* is very easily defined, for it comes from the Latin word meaning to go across. In astronomical study one heavenly body, *A*, although at a great distance from another, *B*, may seem to glide across *B* because it passes between the earth and *B*. On the celestial sphere, both appear at the same distance from us. An eclipse of the sun is actually a transit of the moon — or part of it — across the solar face. There can be no solar transits by planets whose orbits lie outside that of the earth, but the inner planets, Mercury and Venus, at times pass between us and old Sol. Since they are lighted by the sun and their night sides are turned our way during transits, they appear as small, round, black disks against the solar brilliance.

These planetary transits are quite rare events. The latest for Mercury occurred November 11, 1940; the next will take place November 14, 1953. The 20th century will stage no transit of Venus; the latest such phenomenon occurred December 6, 1882; the next is scheduled for June 8, 2004.

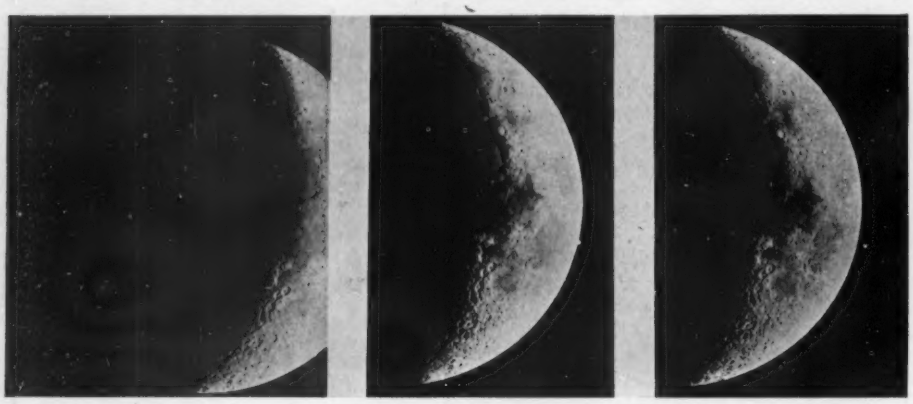
Other uses of the word transit in astronomy apply to the passage of a celestial body across the celestial meridian, and to an instrument for measuring such passages, usually called a transit circle.

Despite the use of "occult" in connection with the practice of magical arts, divinations, and incantations, the word has quite a proper place in astronomical discussions. It means simply "hidden." It is most commonly used in connection with the disappearance of planets and stars behind the moon, the earth's satellite. A total eclipse of the sun could be called an occultation of that body by the moon, but the term is seldom so used.

A planet sometimes occults a distant star. On March 19, 1948, at 9:40 p.m. (EST), brilliant Venus, then in the western evening sky, hid the 6.5-magnitude star 36 Arietis for about five minutes. At that time Venus had the telescopic appearance of the moon a little past the first-quarter phase. Walter H. Haas, of the University of New Mexico, advertised the coming event in his publication *The Strolling Astronomer,* as well as by letter. Later he received several reports of telescopic observations. It was best observed west of the Eastern time zone where the "actors" were not too low in the sky. The disappearance took place at the dark limb of the planet and reappearance at the bright side.

Lunar Occultations

The moon in its revolution around the earth in a little less than a month presents an eastward motion among the stars. Since all the other heavenly bodies are very much farther from us than the moon they appear, with the exception of the sun, to be very much smaller and easily hidden behind the lunar orb. As the moon apparently moves about its own diameter eastward in an hour, stars that meet the most forward part of its eastern limb are hidden for about an hour before they reappear on the opposite western edge. Those contacted by other parts of the moon's forward arc are occulted for shorter periods.



An occultation of the bright star Aldebaran. Left to right: The moon's dark limb approaches the star; immediately after emersion on the moon's bright limb; 1 2/3 minutes after the star's reappearance. Yerkes Observatory photograph.

A telescopic observation of the occultation of a star, especially a bright one by the dark limb of the moon, is often an exciting event, particularly between the times of new moon and first quarter, for then the dim earthshine is easily visible. One should start observing early — perhaps 10 minutes before the predicted time of the occultation — so that the star is seen in the sky well separated from the moon. Smoothly and almost imperceptibly, the moon glides toward the star. For a few seconds at the moment of contact, the star seems to hang on the edge of the moon without the least diminution of its light. Suddenly — it's gone! — almost startlingly, and as completely as if blown out like a candle flame.

Any star (except the sun) is so inconceivably distant that it is a mere point of light to our eyes, and it requires no appreciable time to disappear behind the moon. As the moon has no perceptible atmosphere, there seems to be no gradual dimming of the star before its extinction.

By photoelectric observations, Dr. A. E. Whitford, of the University of Wisconsin, has measured the actual time required for the moon to occult a star. Approximately 2/100 of a second elapses while a large star disappears behind the moon's limb; this short interval cannot be detected by the eye. Dr. Whitford has thus used occultations for measuring the apparent diameters of a few stars. Antares was occulted in April, and will be again on June 9-10 (see page 183).

Since planets have perceptible diameters, their occultations are quite sensibly gradual. Shortly before dawn many years ago the writer, observing with a 6-inch refractor, watched Saturn with its beautiful ring system creep leisurely out from behind the dim earthlit part of the waning moon. The front cover of the *Griffith Observer,* March, 1947, shows three excellent photographs of the "piece-by-piece" reappearance of Jupiter and its four larger satellites from behind the dark lunar limb. Robert E. Millard, the musician-astronomer of Portland, Ore., has described his telescopic observation of a similar dawn event as follows:

"In 1924 I saw the emersion of Venus from the moon's dark limb. It was the most beautiful sight I have seen in the sky. The planet itself was in the crescent phase and glided out from behind the dark part of the moon like a little silver boat on a purple sea."

Shortly past noon on July 31, 1940, an interesting daytime occultation was observed at the Evergreen Observatory by the summer school astronomy class of the University of Oregon. The moon and Venus, about three hours west of the sun, were both at the crescent phase with the cusps pointing down. In the deep blue afternoon sky both bodies were faintly visible without optical aid. Through our telescopes little Venus, much the brighter of the two, gradually descended — points down — toward the round, illuminated side of the big moon. Soon the Venusian points touched the lunar horizon, slowly sank until only the upper, rounded limb of the planet was visible — then all was gone. Venus had set behind a very distant horizon.

MEDAL AWARD

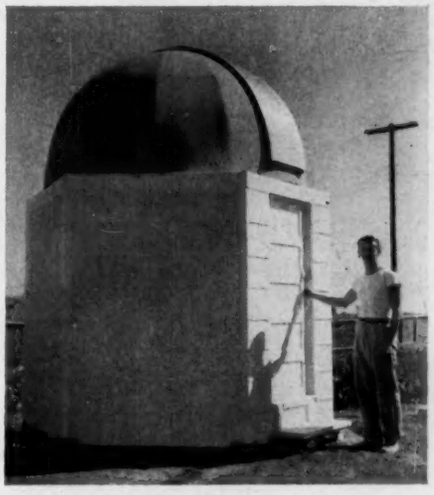
For 1949, the American Academy of Arts and Sciences has awarded its Count Rumford medal for discoveries in the fields of light and heat to Dr. Ira S. Bowen, director of the Mount Wilson and Palomar Observatories.

GLEANINGS FOR ATM's

A Back-yard Observatory and an Indoor Telescope

FOR A LONG TIME I have wanted to have a back-yard observatory, as no doubt have many other amateurs in all parts of the country. With spare time of three months and simple hand tools, I have reached the point where the exterior of my observatory is complete, although there is still considerable work to be done on the interior.

The dome has an inside diameter of eight feet and the base of the dome is 6½ feet from the floor. The dome framework is made from circular sections cut from pine planking. The covering is aluminum sheeting 0.025 inch thick. The dome revolves, and is supported on six skate wheels spaced equally around its base. There are also six additional skate wheels set perpendicular to the others to keep the dome on the track while revolving. The dome slot is two feet wide and its covering is completely removed when the telescope is in use. This may seem undesirable, but I find it to the contrary. From a construction standpoint, there are no tracks to make, mount, or align. The slot covering is light, slips into place nicely, and locking depends only on sliding one movable piece into place. In almost no time at all it can be removed and placed on the lawn outside the observa-



Arleigh J. Oliver at his observatory.

tory. There seems to be less chance for leaks to develop than in a more elaborate arrangement.

The walls of the observatory are of pine studding with pine siding covered with asbestos shingles. The corner shingles are of scrap aluminum left over from the dome covering. These are bent 60 degrees to conform to the hexagonal shape of the observatory.

The observatory houses a 6-inch refracting telescope, its object glass of professional make. The mounting was built by me over a period of years. The mounting pedestal is embedded in one cubic yard of concrete at the base. This observatory is situated approximately eight miles east of Sacramento proper. There are no bright lights to mar the fine seeing that we usually enjoy here. So pretty soon I'll be able to settle down to some real observing.

ARLEIGH J. OLIVER
2520 Avalon Drive
Sacramento 15, Calif.

IN THE February issue, Mr. Parmenter remarked that many people fail to use their instruments because of having to "withstand the rigors of observing in the chill of the night."

I am prompted to describe my 5-inch refractor, which is mounted as a Gerrish polar telescope. The eyepiece end is passed through a short length of 6" pipe,

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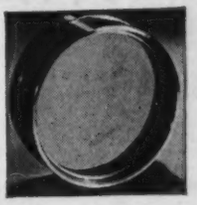

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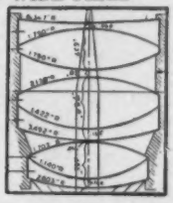

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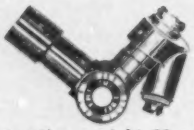

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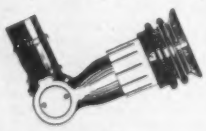

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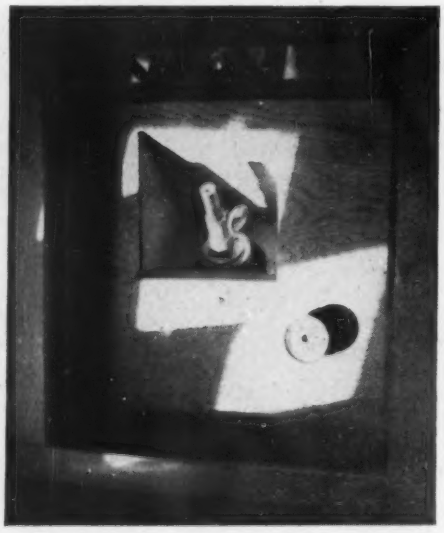
Rolin Gebelein and the polar telescope.

machined round on the outside so it turns smoothly on two ball-bearing skate wheels. This prevents the weight of the instrument from falling on the tube. The lower bearing is a Timken roller bearing, and the 8-inch flat at the objective end is rotated on this bearing by means of miter gears and a flexible cable.

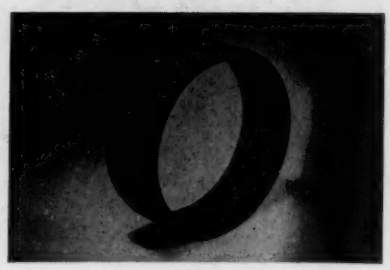
In operation, the plywood panel is put in position after the storm window is removed, and the inside window is raised up and hooked in place, giving access to the controls of the telescope. We are using at present, in place of a finder, a very low-power eyepiece, but are working up a finder that will operate through the main tube by use of a flat that raises and lowers inside the tube.

My son Rolin and I are very satisfied with the arrangement, and feel that the comfort obtained by a warm observing room more than offsets the fact that not all of the sky can be seen.

HARRY GEBELEIN
1207 Britton Rd., Rochester 2, N. Y.



From inside the building: plywood panel, eyepiece, and control for flexible shaft.



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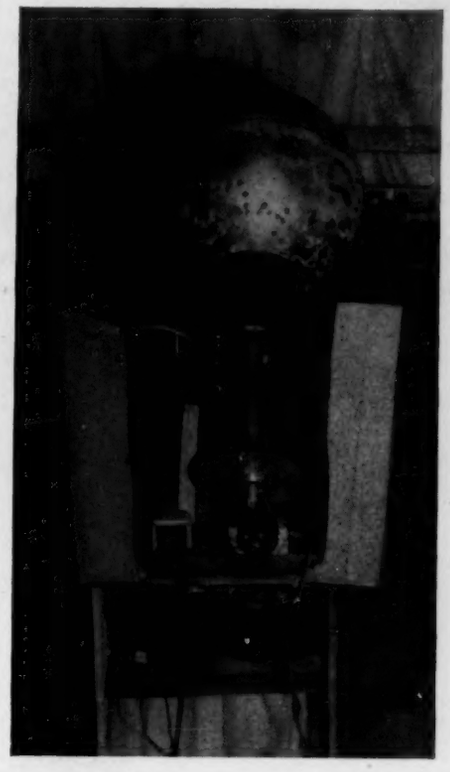
A HOMEMADE PLANETARIUM

THE article on planetariums in the January issue is of much interest. I am sending a photo of my planetarium projector in the belief that there may be some people who don't know that, with a little practice, it is easy to turn out an inexpensive and simple pinhole projector.

The aluminum globe was located in a secondhand store. Before removing the terrestrial map, the co-ordinate circles



were traced with a razor blade. A Norton's **Atlas** was viewed in a mirror, and stars were located, section by section, with an automatic center punch. Holes made with a small electric drill were too large for the stars, so each was covered with tape and pricked with a needle. This is the neatest way of getting the proper sizes of clean little openings.

The mounting is the equatorial head mass-produced for my students at Howard University (**Sky and Telescope,** VII, 90, February, 1948). There is no support on the north end to cast a shadow. The flashlight bulb at the center of the globe is mounted on a dowel rod running up the polar axis. Diurnal motion is produced by a spring motor driving a pulley which was formerly on my Whizzer motorbike. A record-player turntable is placed on a shelf under the projector, and an optical pointer runs off the same transformer that lights the projector. The dome is just a parachute hung by several hundred strings.

WILLIAM A. CALDER
Dept. of Physics and Astronomy
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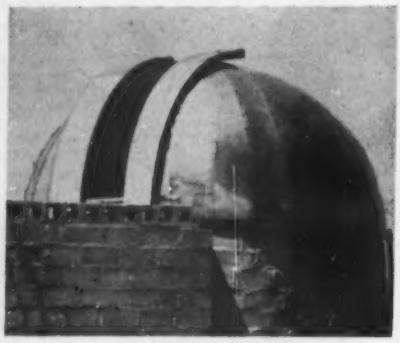

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MONTHLY PAYMENTS

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

SATELLITES OF SATURN

Two of Saturn's satellites are undergoing phenomena similar to those of Jupiter's bright moons, and the following table is adapted for United States observers from the **Handbook** of the British Astronomical Association. The date is given first, then the time (UT), the name of the satellite (Te—Tethys, Di—Dione), and the event: eclipse immersion I, eclipse emersion E; occultation disappearance D, occultation reappearance R; transit of satellite T; transit of shadow S.

Only the times of beginning of T and S are given. For Tethys T takes 80 minutes at the beginning of May and about 95 minutes by the middle of June. Tethys shadow transits take about 135 minutes to 145 minutes, while Dione shadow transits require 50 minutes at the beginning of May and about 90 minutes by June 15th. The magnitudes of these satellites are 10.5 for Tethys and 10.7 for Dione, and their respective synodic periods are $1^d\ 21^h.3$ and $2^d\ 17^h.7$.

May 3, 2:48 Di I, 3:55 Di E; 4, 8:30 Te T, 8:40 Te S; 5, 7:09 Te D, 9:37 Te E; 6, 5:49 Te T, 5:59 Te S; 7, 4:28 Te D, 5:14 Di S, 6:57 Te E; 8, 3:07 Te T, 3:18 Te S; 9, 1:46 Te D, 4:16 Te E; 11, 1:36 Te E, 7:52 Di I, 9:07 Di E; 14, 1:33 Di I, 2:51 Di E; 18, 4:00 Di S; 22, 6:37 Di I, 6:56 Te D, 8:02 Di E, 9:32 Te E; 23, 5:36 Te T, 5:49 Te S; 24, 4:15 Te D, 6:51 Te E; 25, 2:54 Te T, 3:08 Te S; 26, 1:33 Te D, 4:10 Te E; 29, 2:46 Di S.

June 2, 5:23 Di I, 6:56 Di E; 8, 6:44 Te D, 9:26 Te E; 9, 5:23 Te T, 5:40 Te S; 10, 4:02 Te D, 6:45 Te E; 11, 2:42 Te T, 2:59 Te S; 12, 1:21 Te D, 4:04 Te E; 13, 4:09 Di I, 5:49 Di E.

METEORS IN MAY

Amateur observers may wish to watch for the so-called Eta Aquarid meteors in the pre-dawn skies from May 4th to 6th, when up to 10 meteors per hour may be counted. The **Handbook** of the British Astronomical Association for 1948 states that there are grounds for believing that the Eta Aquarids are merely the beginning of the great daylight Piscid stream observed by radar. In the 1949 **Handbook** this shower is divided into nine streams, beginning May 5th and extending to July 18th.

MOON PHASES AND DISTANCE

First quarter	May	5, 21:33
Full moon	May	12, 12:51
Last quarter	May	19, 19:22
New moon	May	27, 22:24
First quarter	June	4, 3:27

	May	Distance	Diameter
Perigee	$10^d\ 15^h$	224,900 miles	33′ 00″
Apogee	$22^d\ 14^h$	251,600 miles	29′ 31″

Moon runs high May 2: +28° 17′
Moon runs low May 15: −28° 15′
Moon runs high May 30: +28° 12′

VARIABLE STAR MAXIMA

May 3, T Cephei, 5.8, 210868; 6, S Virginis, 7.1, 132706; 7, V Coronae Borealis, 7.4, 154639; 11, R Carinae, 4.6, 092962; 15, T Aquarii, 7.9, 204405; 26, V Cassiopeiae, 7.9, 230759. June 1, R Octantis, 7.9, 055686; 3, R Canum Venaticorum, 7.7, 134440a; 6, R Reticuli, 7.7, 043263.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

MINIMA OF ALGOL

May 3, 2:53; 5, 23:42; 8, 20:31; 11, 17:20; 14, 14:09; 17, 10:57; 20, 7:46; 23, 4:35; 26, 1:24; 28, 22:13; 31, 19:02. June 3, 15:51; 6, 12:40; 9, 9:29.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See Sky and Telescope, Vol. VII, page 260, August, 1948, for further explanation.

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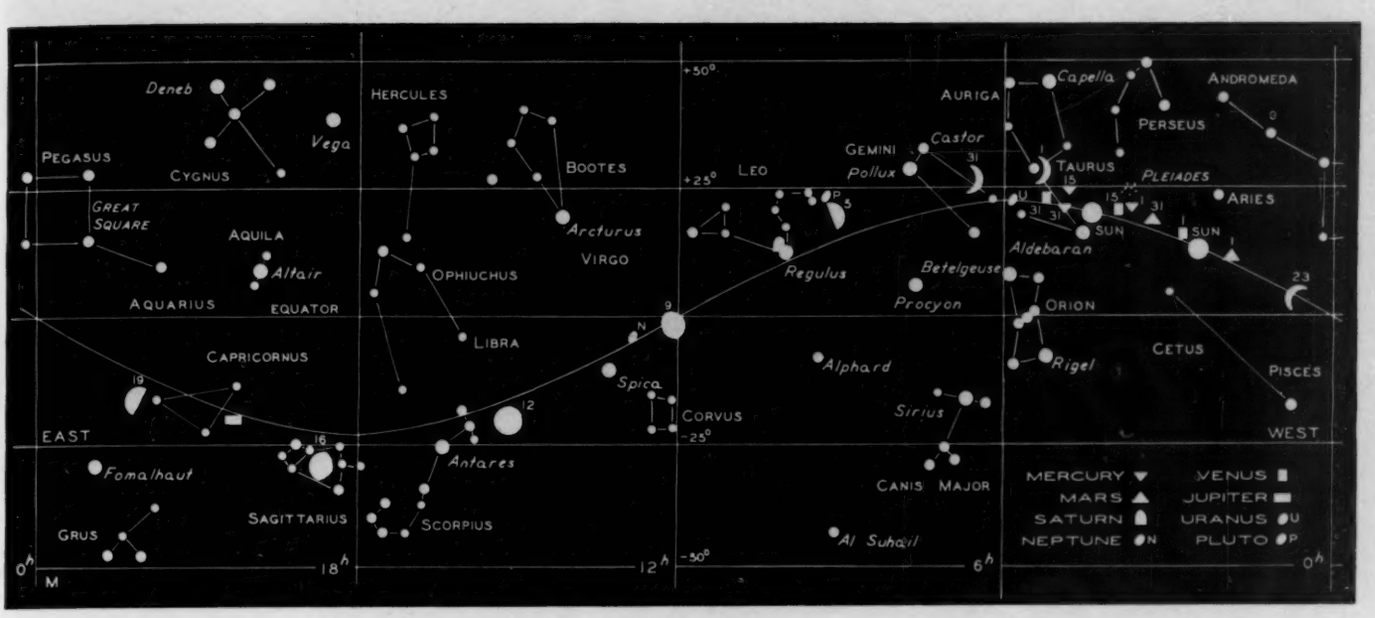

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury attains greatest elongation east on May 10th, 21° 32′ from the sun. This will be the most favorable apparition this year, Mercury actually setting after twilight ends; it will be situated 8° north of Aldebaran, and of magnitude +0.6. On the 1st of May, the planet is just south of the Pleiades, setting 1½ hours after the sun.

Venus, having passed conjunction with the sun last month, comes into view at the end of May, setting nearly an hour after sunset. The planet will be of magnitude −3.4, and should be visible with the unaided eye.

Mars is in the morning sky, too close to the sun to be seen.

Jupiter rises about midnight local time. It begins retrograde motion on May 20th, hence appearing almost stationary all month. The Jovian magnitude is −2.0, and the telescopic disk is about 42 seconds of arc in diameter.

Saturn reaches eastern quadrature with the sun on May 21st, appearing on the meridian at sunset. It is moving slowly eastward, gradually increasing its distance from Regulus.

Uranus is approaching the sun, and cannot be well observed.

Neptune will be favorably placed for telescopic observation, on the meridian about 9 p.m. It is retrograding in central Virgo, between the stars 44 and 38, moving past the latter star at the end of the month. See page 134, March issue, for a chart of Neptune's path.

E. O.

OCCULTATION PREDICTIONS

May 2-3 **49 Aurigae** 5.0, 6:32.0 +28-03.8, 5, Im: **F** 2:41.6 −1.3 −0.2 67. Em: **F** 3:33.0 +0.4 −2.3 319.

May 3-4 **Upsilon Geminorum** 4.2, 7:32.8 +27-00.7, 6, Im: **H** 2:54.0 ... ... 38. Em: **H** 3:17.8 ... ... 0.

May 8-9 **Eta Virginis** 4.0, 12:17.3 −0-23.0, 11, Im: **H** 8:02.4 −2.7 +0.2 61. Em: **H** 8:30.8 +0.5 −3.6 11.

June 9-10 **Alpha Scorpii** 1.2, 16:26.3 −26-19.2, 13, Im: **A** 2:39.8 −1.0 −0.3 138; **B** 2:38.0 −1.0 −0.1 135; **C** 2:38.3 −0.5 −0.9 154; **D** 2:33.6 −0.6 −0.4 147; **E** 2:43.4 ... ... 193. Em: **A** 3:48.3 −2.1 +0.2 263; **B** 3:47.0 −1.9 +0.2 266; **C** 3:36.1 −2.5 +0.8 251; **D** 3:34.6 −2.1 +0.7 257; **E** 2:55.0 ... ... 213.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, all data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, **UT**, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

A	+72°.5, +42°.5	**E**	+91°.0, +40°.0
B	+73°.6, +45°.6	**F**	+98°.0, +30°.0
C	+77°.1, +38°.9	**G**	+114°.0, +50°.9
D	+79°.4, +43°.7	**H**	+120°.0, +36°.0
		I	+123°.1, +49°.5

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computations of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo** — **LoS**), and multiply **b** by the difference in latitude (**L** — **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

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Mappa Coelestis Nova

A striking new wall chart by Josef Klepesta shows the stars brighter than magnitude 5.0 in six different colors according to their spectral classes. The star name or number, Greek letter, and visual magnitude to hundredths are given for each star. Mappa Coelestis Nova is decorative, and provides in a readily accessible form a mine of information for the stargazer.

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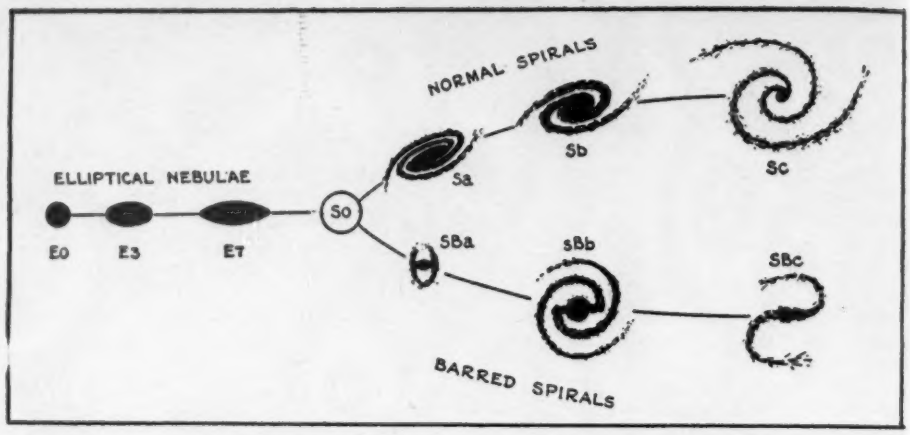
DEEP-SKY WONDERS

THIS MONTH, instead of individual charts, we have one large area extending roughly from 12 to 13 hours and +10° to +20° from the Beyer-Graff **Atlas**. This borderline between Coma and Virgo is one of great confusion of exterior galaxies. A fair telescope cannot find a spot where faint images are not half seen. This is the northern half of the famous Coma-Virgo region of galaxies. Our next installment will treat similarly an equal area south of this one.

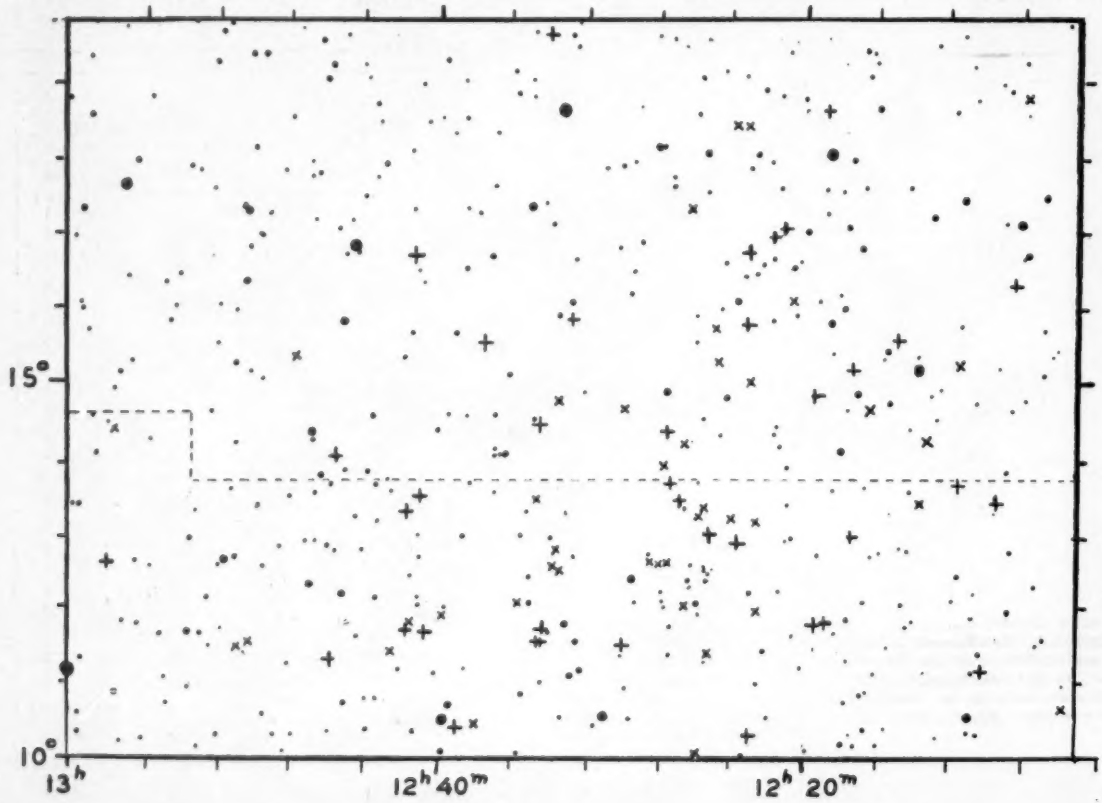
The list gives **New General Catalogue** number; Messier number, if any; position in 1950 co-ordinates; magnitude; apparent size; and type (see diagram). To facilitate finding, the objects have all been labeled on the **Atlas of the Heavens** chart opposite. The back cover is a photograph of perhaps the richest portion of this entire region (see In Focus).

WALTER SCOTT HOUSTON



The sequence of types of extragalactic nebulae, from the book, "Realm of the Nebulae," by Edwin P. Hubble. S0 is a transition stage at which structure, not always spiral, can just be detected. Compare the larger images on the back cover with the diagram, and then check your identifications in the table below.

NGC	*M*	*R.A.* 12h	*Dec.* ° ′	*Mag.*	*Size*	*Type*
4064		1m.6	+18 43	12.8	3.5-1.5:	S
4124		5.6	10 40	12.5	3.6-1.4	S
4152		8.1	16 19	12.7	1.0-0.9	S
4168		9.8	13 29	12.8	1.4-1.4	E
4178		10.2	11 09	12.4	4.7-1.9	S
4189		11.2	13 42	13.0	.....	....
4192	98	11.3	15 11	11.4	8.0-2.0	Sb
4212		13.1	14 11	12.1	2.6-1.8	Sc
4216		13.4	13 25	11.3	7.0-1.0	Sb
4237		14.7	15 36	12.6	1.5-1.0	S
4254	99	16.3	14 42	10.5	4.5-4.5	Sc
4262		17.0	15 09	12.6	1.5-1.4	E:
4267		17.2	13 03	12.6	2.2-2.2	E
4293		18.7	18 40	11.7	5.0-2.0	S
4294		18.7	11 47	13.0	.....	....
4298		19.0	14 53	12.5	3.0-1.5	S
4299		19.2	11 47	13.1	.....	....
4302		19.2	14 53	13.2	.....	....
4321	100	20.4	16 06	10.8	5.0-5.0	Sc
4340		21.0	17 00	13.0	.....	....
4350		21.4	16 58	12.0	2.0-0.4	E
4371		22.4	11 59	12.1	1.7-1.3	SBa
4374	84	22.6	13 10	10.9	2.9-2.6	E
4377		22.7	15 02	12.9	1.0-0.8	E
4379		22.8	15 53	13.0	.....	....
4382	85	22.8	18 28	10.5	4.0-2.5	E
4380		22.9	10 17	12.8	3.3-2.0	S
4383		23.0	16 45	12.9	1.2-0.7	E
4388		23.3	12 56	12.2	5.0-1.0	S
4394		23.4	18 29	12.2	4.0-3.5	SBb
4406	86	23.7	13 13	10.9	3.8-2.9	E
4419		24.4	15 19	12.2	2.3-0.7	Sc
4425		24.7	13 01	13.1	.....	....
4429		24.9	11 23	11.7	3.0-1.0	Sa
4435		25.2	13 21	11.8	1.6-1.0	E
4438		25.3	13 17	11.9	8.0-3.0	Sb
4442		25.6	10 05	11.4	3.2-1.0	SBa
4450		25.9	17 21	11.4	4.4-3.5	Sb
4452		26.2	12 02	13.2	.....	....
4459		26.5	14 15	11.9	2.0-1.0	E
4461		26.6	13 28	12.4	3.0-1.0	S:
4473		27.3	13 42	11.7	3.0-1.5	E
4474		27.4	14 21	12.9	1.5-0.7	E
4476		27.5	12 37	13.2	.....	....
4477		27.6	13 55	11.8	2.5-1.8	SBa
4478		27.8	12 36	12.5	1.2-1.0	E
4486	87	28.3	12 40	10.7	3.3-3.3	E
4501	88	29.5	14 42	10.9	6.0-3.0	Sc
4503		29.6	11 27	12.8	2.5-0.9	E
4540		32.3	15 50	12.9	1.4-1.0	S
4548		32.9	14 46	11.9	4.0-3.6	SBb
4550		32.9	12 30	12.7	2.7-0.8	Sa
4552	89	33.1	12 50	11.3	2.2-2.2	E
4561		33.6	19 36	12.9	1.2-1.1	I:
4564		34.0	11 43	12.1	2.0-0.6	E
4567		34.0	11 32	12.3	2.4-1.6	S
4568		34.1	11 31	12.2	3.6-1.8	S
4569	90	34.3	13 26	11.2	6.0-3.0	Sc
4571		34.3	14 28	12.8	3.0-2.7	S
4579	58	35.1	12 05	11.0	3.6-3.2	SBc
4595		37.3	15 34	13.1	.....	....
4596		37.4	10 27	12.2	2.4-0.9	SBa
4608		38.7	10 26	12.7	2.0-1.5	S
4621	59	39.5	11 55	11.4	2.7-1.6	E
4638		40.2	11 43	12.2	1.0-0.5	E:
4639		40.3	13 31	12.3	1.5-1.2	S
4647		41.0	11 51	12.0	2.5-2.2	S
4649	60	41.1	11 49	10.6	3.9-3.1	E
4651		41.2	16 40	11.8	3.2-2.2	S
4654		41.4	13 23	11.7	4.8-3.3	S
4660		42.0	11 26	12.3	1.0-0.5	E
4689		45.2	14 01	12.0	3.0-2.0	S
4694		45.7	11 15	12.6	2.0-0.6	E:
4710		47.1	15 26	12.0	3.5-0.5	Sa
4754		49.7	11 35	12.0	3.0-1.0	SBa
4762		50.4	11 31	11.8	3.7-0.4	Sa
4866		57.0	14 27	12.1	3.2-0.5	Sa
4880		57.7	12 45	13.1	.....	....

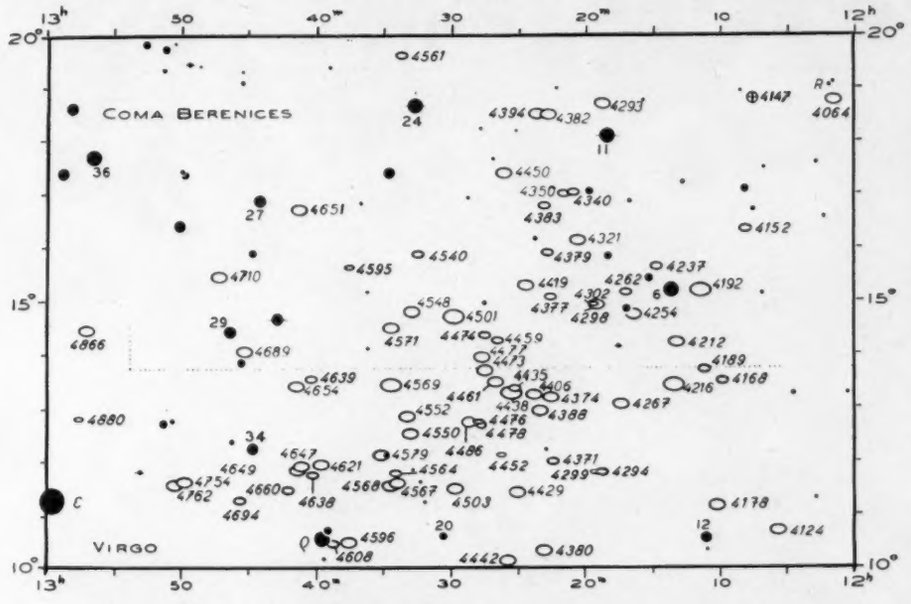


As in our February and March issues, this Beyer-Graff chart is to a scale of one centimeter to each degree; star dots are by magnitude intervals; limiting magnitude is 9; but in this case north is at the top of the chart. Co-ordinates are for 1950. Originally plotted objects are X's; those added to complete the listing from Harvard "Annals" 88 are crosses (+), and their positions are approximate. Two objects not listed have been elimnated, so the chart and the list should agree, except for NGC 4147, which is a globular cluster, and NGC 4064, which is off the edge of this chart.

In Focus

AT HARVARD'S Oak Ridge station in Harvard, Mass., the newest instrument is the Jewett memorial telescope, a Schmidt camera with a 33-inch mirror and 24-inch correcting plate. Its focal length is 84 inches, giving a plate scale of 98 seconds of arc per millimeter, but its field of fine images extends over all of its 8-by-8-inch plate (190 millimeters wide). From along one edge of a routine photograph taken with this telescope our back cover has been enlarged about five times, to show a striking region of galaxies straddling the border of Virgo and Coma Berenices, at a distance of about eight million light-years from the solar system.

This Schmidt telescope orients the field on the plate at 45° to compass directions. Thus NGC 4459, the conspicuous elliptical galaxy in the lower left corner of the back cover, is in the north corner of the field. To its right, nearly centered, is NGC 4477. Above that, one of two galaxies is NGC 4461, a spiral whose type is indefinite, as indicated by the colon in its listing in Deep-Sky Wonders. At its left is a smaller object too faint to list there. A line through NGC 4461 to NGC 4459 runs practically from south to north. Just above the center of the back cover is another pair of galaxies, NGC 4435 and 4438. Above these, with the aid of charts in Deep-Sky Wonders, the reader may identify NGC 4406, 4425 (not on this chart), 4388, and 4374. Compare their images with their classifications. Many other fainter galaxies in the field indicate the richness of the metagalaxy in this direction.



A portion of the "Atlas of the Heavens," on which have been plotted the positions and designations of all the galaxies listed for this region in Harvard "Annals" 88, except NGC 4425, for which there was no space. On the back cover, this galaxy is about three inches from the top and nearly four from the right.

CLEVELAND EXHIBIT RULES AND CONVENTION NOTES

(Continued from page 173)

stracts of at least 50 words. These should be sent to the executive secretary of the Astronomical League, James B. Rothschild, 209 West 21 St., New York 11, N. Y. As already announced, the time for oral presentation shall not normally exceed 10 minutes, and complete papers or more extensive abstracts may be submitted before the close of the convention, for later inclusion in the printed proceedings to the extent that space permits.

Paging All Juniors

A special notice to junior astronomers calling upon them to take an active part in the convention has been issued by Grace C. Scholz, chairman of the Astronomical League committee on junior activities. She writes:

"We would especially like to have juniors present short papers on their activities and astronomical subjects of interest to them. In the exhibit, there will be a special prize for the best instrument of any type constructed by a junior 18 years of age or under. If you have an entry, follow the exhibit rules, and take your instrument with you or have it brought to Cleveland."

Accommodations

The Wade Park Manor, East 107th St. and Park Lane, Cleveland (hotel headquarters for the convention), and the Tudor Arms Hotel, Cleveland 6, are conveniently located with regard to the meeting place. All reservations are to be made directly with these or other hotels and the numerous tourist homes in the vicinity. Rates at the Wade Park Manor are: single, $5.50 per night; room with twin beds, $8.50. The Tudor Arms has all double rooms with twin beds, from $7.00 to $10.00 per room. Meals will be taken at various restaurants in the neighborhood of the physics building of the Case Institute of Technology, where the convention sessions will be held.

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Classified advertisements for this column are 8 cents a word, including address; minimum ad 20 words. Remittance must accompany orders. Write Ad Dept., Sky and Telescope, Harvard College Observatory, Cambridge 38, Mass.

WANTED: 3" or 4" refractor, 4" preferred. Must be in new condition and priced reasonably. Wesley Wilson, 824 Spruce St., Quincy, Ill.

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MOUNTINGS: Built to order. Send me your needs. Clock drives, cells, and parts. Will edge mirrors up to 16" size, to fit cell. Leo F. Grandmontagne, 199 Wychwood, Youngstown 5, Ohio.

LABCOTE: Lens coating for your telescopes, binoculars, cameras, etc. LABFLECT: Fluoride protected aluminizing. 6" mirrors, $3.50; 8", $4.50 FOB. Eyepieces for sale: Kellner wide field, achromatic, coated, 1 1/16" E.F.L., 1¼" diameter, $5.00. Price list and information on request. H. Leroy Benfer, Box 5160, Washington 19, D. C.

HERE AND THERE WITH AMATEURS

*Members receive *Sky and Telescope* as a privilege of membership. †Member organizations of the Astronomical League.

State	*City*	*Organization*	*Time*	*Meeting Place*	*Communicate With*
ALABAMA	Gadsden	*Ala. A.A.*	7:30, 1st Thu.	Ala. Power Audit.	Brent L. Harrell, 1176*W* or 55
CALIFORNIA	Los Angeles	*L.A.A.S.*	7:45, 2nd Tue.	Griffith Obs.	H. L. Freeman, 853½ W. 57 St.
	Norwalk	*Excelsior Tel. Club*	7:00, Thu.	Excelsior Union H.S.	Geo. F. Joyner. 410 Sproul St.
	Oakland	**Eastbay A.A.*	8:00, 1st Sat.	Chabot Obs.	Miss H. E. Neall, 1626 Chestnut, B'keley
	Palo Alto	†**Peninsula A.S.*	7:30, 1st Fri.	Community Center	Miss D. Rossiter, 922 Roble Ave., Menlo Pk.
	Sacramento	**Sac. Val. A.S.*	8:00, 1st Tue., bi-mon.	Sacramento College	Mrs. Helen Schopke, 3111 12 Ave. (17)
	San Diego	*Ast. Soc. of S.D.*	7:30, 1st Fri.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	†*A.T.M. Ast. Club*	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	G. A. Sharpe, 4477 Muir, *Bayview* 3757
CONNECTICUT	New Haven	†*New Haven A.A.S.*	8:00, 4th Sat.	320 York St.	Mrs. Eda Becroft, Box 28, Yalesville
	Norwalk	*Norwalk A.S.*	8:00, Last Fri.	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-5947
	Stamford	**Stamford A.A.*	8:00, 3rd Fri.	Stamford Museum	Wm. L. Dutton, Box 331, Noroton
DIST. COL.	Washington	†*Nat'l. Cap. Ast'mers*	8:00, 1st Sat.	Comm Dept. Audit.	Jewell Boling, 1717 P St. NW, *Du.* 2969
FLORIDA	Daytona Beach	*D. B. Stargazers*	8:00, Alt. Mon.	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
	Jacksonville	**J.A.A.C.*	8:00, 1st, 3rd Mon.	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
	Key West	†*Key West A.C.*	8:00, 1st Wed.	Private homes	W. M. Whitley, 1307 Div. St., 724-R
	Miami	*South'n Cross A.S.*	7:30, Every Fri.	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26 Rd.
GEORGIA	Atlanta	*Atlanta Ast'mers*	7:30, 3rd Fri.	Agnes Scott College	W. A. Calder, Agnes Scott College
ILLINOIS	Chicago	†**Burnham A.S.*	8:00, 2nd Tue.	Chi. Acad. of Sci.	J. M. Showalter, 6200 Kenmore Ave.
	Geneva	**Fox Valley A.S.*	8:00, 1st Tue.	Geneva City Hall	Joseph Zoda, 501 S. 6th, St. Charles
	Joliet	†*Joliet A.S.*	8:00, 3rd Mon.	Jol. Township H.S.	Mrs. Robert L. Price, 403 Second Ave.
	Moline	†**Popular A.C.*	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, Route 1
INDIANA	Indianapolis	†*Indiana A.S.*	2:15, 1st Sun.	Riley Library	E. W. Johnson, 808 Peoples Bank Bldg.
KANSAS	Topeka	**Topeka A.A.S.*	7:30, 2nd Mon.	Topeka H.S.	Miss N. Utschen, 1607 Wayne Ave.
	Wichita	†**Wichita A.S.*	8:00, 1st Wed.	.....	Dollie Ratcliff, 801 Maple, 2-1822
KENTUCKY	Louisville	†*L'ville A.S.*	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 621 34th St.
	Owensboro	†**Owensboro A.C.*	8:00, 3rd Sat.	Public Library	Herman Batt, 1507 Hathaway St.
LOUISIANA	New Orleans	*A.S. of N.O.*	8:00, Last Wed.	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MAINE	Portland	†*A.S. of Maine*	8:00, 2nd Fri.	Private homes	H. Harris, 27 Victory Ave., S. Portland
MASSACHUSETTS	Cambridge	†**Bond A.C.*	8:15, 1st Thu.	Harvard Obs.	Miriam Dickey, Harvard Observatory
	Cambridge	†**A.T.M.s of Boston*	8:00, 2nd Thu.	Harvard Obs.	Frank M. Roe, 35 Pemberton St. (40)
	Springfield	†**S'field Stars*	8:00, 2nd Wed.	Private homes	F. D. Korkosz, Mus. Nat. Hist., 2-4317
	Worcester	†**Aldrich A.C.*	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	Ralph A. Wright, 4 Mason St.
MICHIGAN	Ann Arbor	†**Ann Arbor A.A.A.*	7:30, 2nd Mon.	U. of Mich. Obs.	Stewart W. Taylor, 1106 Birk Ave.
	Battle Creek	†*B. C. A.A. Club*	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett St.
	Detroit	†**Detroit A.S.*	3:00, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Detroit	†**N.W. Detroit A.S.*	8:00, 1st Tue.	Redford H. S.	John W. Broxholm, 21412 Pickford
	Kalamazoo	†*Kalamazoo A.A.A.*	8:00, Sat.	Private homes	Mrs. G. Negrevski, 2218 Amherst, 31482
	Lansing	†**Lansing A.A.*	8:00, 1st, 3rd Wed.	Technical H. S.	Mrs. T. A. Louden, 940 Bensch St. (14)
	Pontiac	**Pontiac A.A.A.*	8:00, 2nd Thu.	Private homes	Mrs. M. Chircop, 147 Prospect St., 21455
MINNESOTA	Duluth	†**Darling A.C.*	8:00, 1st, 3rd Fri.	Darling Obs.	R. Schmidt, 1910 Hughitt, Superior, Wis.
	Minneapolis	*M'polis A.C.*	7:30, 1st, 3rd Wed.	Public Library	Mrs. M. S. Skahen, 500 Ridgewood Ave. (4)
MISSOURI	Kansas City	**A.A. & T.M.s*	8:00, 4th Sat.	Private homes	Reginald Miller, Merriam, Kans.
	St. Louis	*St. Louis A.A.S.*	8:00, Sat.	Private homes	A. M. Obrecht, 2913 Park Ave.
NEVADA	Reno	*A.S. of Nev.*	8:00, 4th Wed.	Univ. of Nevada	G. B. Blair, University of Nevada
NEW JERSEY	Jersey City	†*Revere Boys Club*	7:15, Mon., Tue.	Gregory Mem. Obs.	Enos F. Jones, 339 Wayne St.
	Teaneck	†*Bergen Co. A.S.*	8:30, 2nd Wed.	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
NEW YORK	Buffalo	†**A.T.M.s & Observers*	7:30, 1st, 3rd Wed.	Mus. of Science	R. M. Missert, 29 Crosby Ave., Kenmore
	New York	**A.A.A.*	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *En.* 2-8500
	New York	†*Junior A.C.*	7:30, 4th Fri.	Amer. Mus. Nat. Hist.	J. Rothschild, Hayden Plan., *En.* 2-8500
	Rochester	*Rochester A.C.*	8:00, Alt. Fri.	Univ. of Rochester	Mrs. R. Dakin, Bushnell's Basin, Pittsford
	Schenectady	†*S'tady A.C.*	8:00, 3rd Mon.	Schenectady Mus.	G. Staffa, 32 Front St.
	Wantagh	*Long Island A.S.*	8:00, Sat.	Private homes	A. R. Luechinger, Seaford Ave., 1571
N. CAROLINA	Greensboro	†**Greensboro A.C.*	8:00, 1st Thu.	Woman's Coll., U.N.C.	Mrs. Edith Settan. 1030 W. Market St.
	Rocky Mount	*Hi-Y A.C.*	8:00, Tue.	YMCA	J. A. Harper, YMCA
	Winston-Salem	†**Forsyth A.S.*	7:30, Last Fri.	Private homes	Kenneth Shepherd, 703 W. E. Blvd.
OHIO	Cincinnati	**Cin. A.A.*	8:00, 2nd Fri.	Cincinnati Obs.	T. R. Stoner, RR 8, Cin. 30, *Be.* 7937-R
	Cincinnati	**Cin. A.S.*	8:00, 3rd Wed.	5556 Raceview Ave.	A. Moore, Hopkins & Letitia Sts., Amelia
	Cleveland	*Cleveland A.S.*	8:00, Fri.	Warner & Swasey Obs.	Virginia Burger, Warner & Swasey Obs.
	Columbus	**Columbus A.S.*	8:00, Last Tue.	McMillin Obs.	J. A. Hynek, Ohio State Univ.
	Dayton	*A.T.M.s of Dayton*	3rd Sat. Eve.	Private homes	F. E. Sutter, RR 7, Bx. 253A (9)
	Warren	†*Mahoning Val. A.S.*	8:00, Thu.	Private homes	S. A. Hoynos, 1574 Sheridan, NE. 25034
	Youngstown	**Y'town A.C.*	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 905 Brentwood
OREGON	Portland	†**Portland A.S.*	7:00, 1st Wed.	Central Pub. Lib.	H. J. Carruthers, 427 S. E. 61 Ave.
	Portland	†*A.T.M. & Observers*	8:00, 2nd Tue.	Private homes	N. C. Smale, 831 N. Watts St.
PENNSYLVANIA	Beaver	†**Beaver Co. A.A.A.*	8:00, 4th Tue.	Com'y Bldg., Tamaqui	Mrs. R. T. LuCaric, Box 463, Baden
	Philadelphia	†*A.A. of F.I.*	8:00, 3rd Fri.	Franklin Institute	Edwin F. Bailey, *Rit.* 3050
	Philadelphia	**Rittenhouse A.S.*	8:00, 2nd Fri.	Morgan Physics, U.Pa.	Sarah Lippincott, Sproul Obs., Swarthmore
	Pittsburgh	†**A.A.A. of P'burgh*	8:00, 2nd Fri.	Buhl Planetarium	Charles H. LeRoy, R.D. 2 (15)
RHODE ISLAND	Providence	*Skyscrapers, Inc.*	8:00, Mon. or Wed.	Ladd Observatory	Ladd Obs., Brown U., *Ga.* 1633
S. CAROLINA	Columbia	*North'n Cross A.S.*	8:15, Every Mon.	Melton Observatory	Dr. L. V. Robinson, Univ. of S. C.
TENNESSEE	Chattanooga	*Barnard A.S.*	8:00, 2nd Fri.	Jones Observatory	C. T. Jones. 302 James Bldg., 7-1936
	Nashville	**Barnard A.S.*	7:30, 2nd Thu.	Vanderbilt Univ.	Miss J. Saffer, 446 Humphrey St. (10)
TEXAS	Houston	*Houston A.S.*	7:30, Last Fri.	Mus. Nat. Hist. Annex	Mrs. J. Murray, 1007 W. Gray (6)
UTAH	Salt Lake City	*A.S. of Utah*	8:00, 2nd Fri.	City and County Bldg.	Junius J. Hayes, 1148 East 1 S.
VERMONT	Springfield	†*Springfield T.M.'s*	6:00, 1st Sat.	Stellafane	John W. Lovely, 27 Pearl St., 535-W
VIRGINIA	Norfolk	†**A.A.S. of Norfolk*	8:00, 2nd, 4th Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau. 21745
WASHINGTON	Tacoma	*Tacoma A.A.*	8:00, 1st Mon.	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 N. Union Ave.
	Yakima	†**Yak. Am. Ast'mers*	8:00, 2nd Mon.	Cha. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.
WISCONSIN	Madison	†*Madison A.S.*	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	†**Milw. A.S.*	8:00, 2nd Mon.	Public Museum	E. A. Halbach, 2971 S. 52 St., W. Allis
CANADA	Montreal	*RASC, Montreal*	8:00, Every Sat.	4052 Wilson Ave.	DeLisle Garneau, *Dexter* 1802

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of May, respectively.

STARS FOR MAY

CENTRAL in the sky of mid-northern observers early on May evenings is the region containing the pole of the galaxy, 90° from the central line of the Milky Way, which therefore extends generally around the horizon. The absence of multitudes of stars in the zenith is made up, at least for those possessing good telescopes, by hundreds of galaxies, mostly members of the famous Coma-Virgo cluster (see Deep-Sky Wonders and In Focus).

These galaxies are easily seen by us because in this direction we look out through the least possible amount of dust and gas associated with the Milky Way. But above the galactic plane a distance of about 250 light-years is located the open star cluster Coma Berenices, forming a Y-shaped patch of stars best appreciated when seen with binoculars.

This is the best time of year to study Ursa Major, and to discover that the Big Dipper is only part of that truly large bear. On the meridian to the south is Corvus, and above the horizon for those in southern Texas and Florida some stars of the Southern Cross can be seen. The globular cluster Omega Centauri, which looks like a fuzzy 4th-magnitude star, is already above the 40° horizon.